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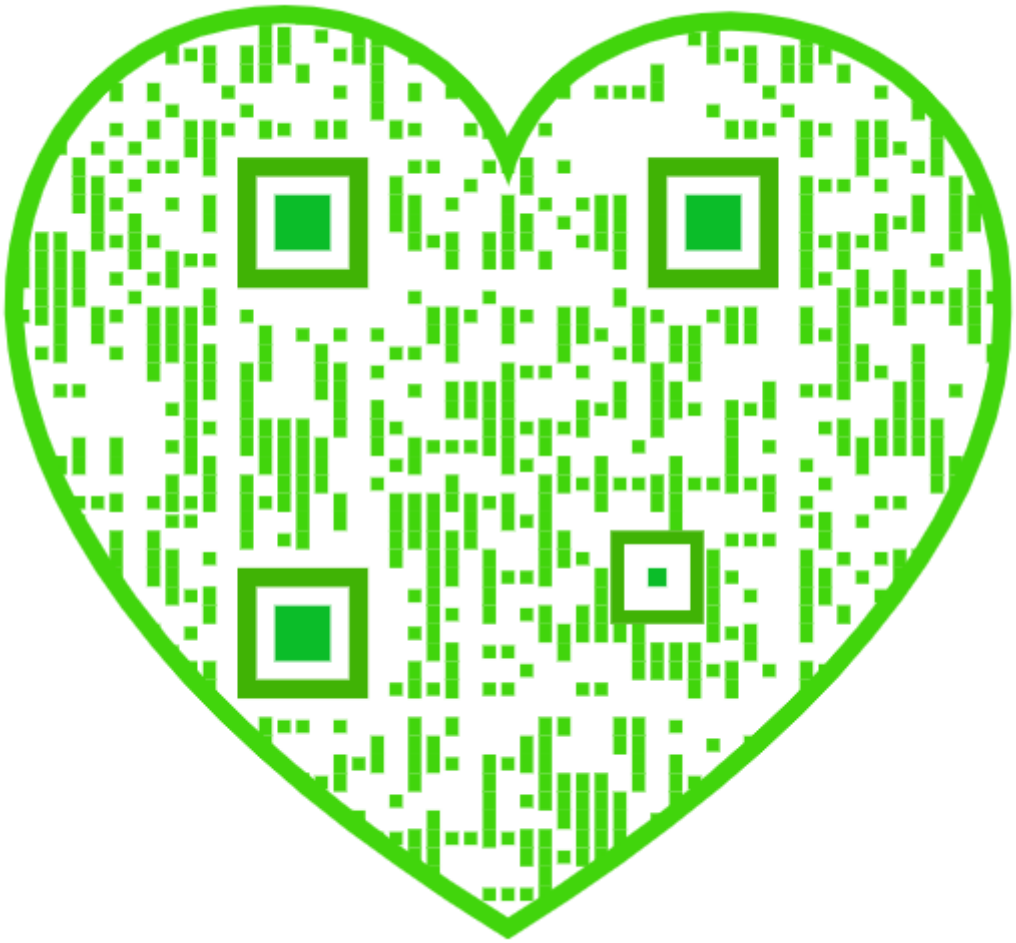

MONTANA AGRICULTURAL COLLEGE
EXPERIMENT STATION.

F. B. LINFIELD, Director.

BULLETIN NO. 67.

Practical Beekeeping

Designed for the Use of the Beginner and Small Apiarist. Adapted to the State of Montana.

BY
RALPH BENTON
Under the Direction Of
R. A. COOLEY, *Entomologist.*

BOZEMAN, MONTANA
JUNE, 1907.

MONTANA AGRICULTURAL COLLEGE EXPERIMENT STATION.

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LETTER OF TRANSMITTAL.

F. B. LINFIELD, Director,
Agricultural Experment Station,
Bozeman, Montana.

Dear Sir:—

The accompanying paper, entitled practical bee-keeping, designed for the use of the beginner and small apiarist, adapted to the state of Montana, has been prepared by Mr. Ralph Benton, a graduate of the Montana Agricultural College in the class of 1906. Mr. Benton is well qualified to write on this subject having had a lifelong experience with bees with his father, who is the Apiarist of the United States Department of Agriculture, and having also had several years of practical experience in Montana. The paper was submitted in lieu of a thesis and was prepared during Mr. Benton's senior year.

Several photographs made by myself are submitted for illustrations; several others have been borrowed, credit for each borrowed cut being placed in the legend.

The results of our experiments in apiculture are summarized by Mr. Benton, it seeming to be desirable to publish a popular bulletin covering in a general way the whole subject of apiculture in Montana, rather than to publish in separate bulletins such a general work and in addition a detailed statement of our experiments.

I recommend that this paper be published as Bulletin No. 67 of our regular series.

R. A. COOLEY,
Zoologist and Entomologist.

Bozeman, Montana, Nov. 15, 1906.

CONTENTS.

Section 1—Structure of the Honey Bee.
Section 2—Some Habits of the Bees.
Section 3—Varieties of Bees and Their Geographical Distribution.
Section 4—Bees and Flowers—Honey Producing Plants.
Section 5—Essentials of a Good Bee Hive.
Section 6—Technique of Handling Bees.
Section 7—Starting an Apiary.
Section 8—Modes of Wintering.
Section 9—Queen Rearing.
Section 10—Methods of Controlling Increase.
Section 11—Production of Honey.
Section 12—Bee Diseases.

Practical Beekeeping

STRUCTURE OF THE HONEY BEE

In order to understand the highly specialized appendages and organs of the honey bee it will be profitable to first consider the structure of a typical insect. The main external structural character separating insects from closely related forms, such as spiders, scorpions, mites and even the larger animals as the cray-fishes and lobsters, is the fact that they uniformly have six legs. These may not in all cases be used for walking, as in the case of some butterflies which employ only four legs, yet have the other two present in a dwarfed condition.

The body of an insect is divided into three easily distinguishable portions,—the head, the thorax and the abdomen. The origin of these three divisions can be better understood if a caterpillar be examined. The caterpillar we find is composed of a series of rings, or metameres, as they are called. The primitive ancestor of insects is believed to have had more metameres than insects now possess, and it is supposed that each segment had a pair of appendages. In the adult insect of today these rings are more or less united into a varying number in different insects. The head is supposed to be formed of several of these segments fused together with the appendages modified to function as mouth parts and sense organs. It is generally agreed that three segments with their three pairs of appendages unite to form the thorax or second section of the body which bears the three pairs of legs. The remaining segments are usually easily distinguishable even in the adult, though in some instances the last two or three are united and their appendages are modified to aid in the deposition of eggs, or for defense, in the form of a stinger, as is the case in the hornets and bees.

Insects as a class are divided up into a series of orders based upon structural differences. The six principal orders are: Orthoptera or grasshoppers, etc.; Hemiptera or true bugs, including

tree hoppers, plant lice, water bugs, etc.; the Coleoptera or beetles; the Lepidoptera, including moths and butterflies; the Diptera, including the true flies; and the Hymenoptera, including the bees, ants, wasps and hornets. It is generally believed that the Hymenoptera compose the highest order of insects, yet these orders have developed parallel to each other. Of the Hymenoptera the supremacy lies between the ants and the bees, and from the number of specialized organs and products of bees, they may be given the higher place. Carrying the subdivision further, the Hymenoptera, so named from their membranous wings, are divided into two sub-orders: the boring Hymenoptera including the sawflies, gall-flies, ichneumon-flies, etc., and the stinging Hymenoptera including the ants, wasps and bees. The bees are called the Apina. They are again subdivided into families, the short tongued bees or Andrenidae, and the long tongued bees or Apidae, the honey bee falling, of course, within the latter group. Apidae are again subdivided and we distinguish the genus Bombus or bumble-bees, the genus Megapis or giant bees, and the genus Apis or the common honey bees. The genus Megapis is separated into species and we have Megapis dorsata, Megapis zonata, and Megapis testacea, the giant bees of India, Java and the Philippines. The genus Apis is separated into the following species,—Apis florea and Apis indica, the small East Indian bees, and Apis mellifera, the European or common bee. To recapitulate briefly, the common honey bee belongs to the class Insecta, order Hymenoptera, super family Apina, family Apidae, genus Apis and species mellifera. So the name of the honey bee is Apis mellifera from the Latin apis, meaning bee and mellifera, meaning honey. From the same given root, apis, comes our word apiculture, meaning the cultivation of bees and also apiary, meaning a collection of colonies of bees.

To return to the structure of the honey bee. We have seen that bees have three pairs of legs borne on the lower side of the thorax. The insect leg is composed of a series of parts with joints between, named from the body down, the coxa, trochanter, femur, tibia, tarsus. There is a tendency among bees to bear upon each tibia a so-called spur. In the first pair of legs this spur is modified to form, with an indentation of the first tarsal segment, a circular comb or cleaner. This is known as the antennae cleaner and serves the bee in cleaning the coat of fine hair on the antennae or feelers. The

antennae are appendages of the head believed to bear sense organs. Cleaning the antennae is accomplished by the bee's throwing the fore leg up over the head, and the antennae fitting in the indentation, is inclosed by the spur and drawn through the circular comb thus formed. By this process, repeated several times, all particles of dust are removed from the antennae by the little teeth of the comb. The tibial spur of the middle leg is used as a crow-bar in the removal of the pellet of pollen from the tibia of the hind leg. In the hind leg the spur is missing, but located in a similar position to that of the antennae cleaner we have a structure known as the wax-forceps which is opened and closed by the bending of the tarsal joint on the tibia. The use of this forceps will be spoken of later in connection with the wax glands.

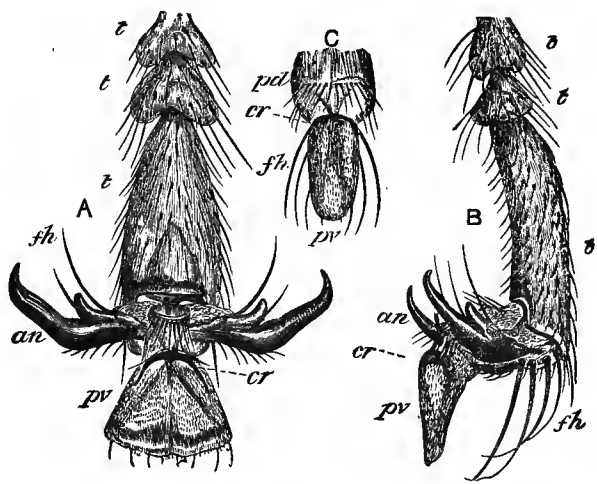


Fig. 1.—Foot of Bee, with the Pulvillus in Use. (magnified fifty times) A, under view of foot; t, t, tarsal joints; an, anguiculi; fh, feeling hairs; pv, pulvillus; cr, curved rod. B, side view of foot; lettering as before. C, central part of sole; pd, pad; cr, curved rod; fh, feeling hairs; pv, pulvillus unopened. (From Cheshire by courtesy of L. Upcott Gill, London.)

The tibia of the hind leg is modified to form a pollen basket known as the corbicula. This basket is formed simply by long curved hairs arranged along the edges of the flattened and indented tibia, curving outward and over, enclosing, when filled, the pellet of more or less adhesive pollen.

The first tarsal joint is somewhat enlarged and greatly flattened and has on its inner surface a series of rows of regularly arranged stiff, bristle-like hairs used by the bee in cleaning itself and known as combs. The use of these combs in collecting pollen will be spoken of at length in the next section on the habits of bees.

There remain a few words to be said in regard to the foot. There is an interesting structure known as the foot pad or pulvillus located between the two forked claws of the foot. This pad produces a secretion of a sticky nature which enables the bee to cling to smooth surfaces. Its action is of interest. The bee, normally walking upon the tips of its claws, finds itself slipping, and in the struggle to stop itself the claws slip, and, in bending under, the sticky pad between them comes in contact with the surface. As the bee lifts the foot in taking another stride the claws serve as a pry and the pad is pulled loose, beginning at one edge as one would pull or peal up a freshly stuck postage stamp. In this way the bee is enabled to crawl on as highly polished a surface as a window pane.

The wings are four in number and are borne on the dorsal part of the first and second thoracic segments. They are membranous and are carried when at rest folded one pair above the other on the back of the body, thus enabling the bee to crawl into its cells with perfect ease. When spread, the two wings are fastened together by a series of hooks on the hind wing which hook into a fold on the fore wing, thus presenting a continuous surface to the air. Bees can fly forward and backward by adjusting the action of the wings.

We will next take up the head and its appendages. The head is triangular in front view, with the mouth located in the lower angle. At the two upper angles are located the two large compound eyes, composed of a great number of hexagonal facets, covered with a fine coating of hairs. Besides these compound eyes the bee has three single eyes or ocelli, located in a triangle on top of the head, one in the center and to the front, and the other two placed laterally. On the front side of the head are borne the two feelers or antennae, which function, it is believed, as sense organs—smell and possibly hearing. These consist of a long, basal segment, the scape, and a series of small segments, the flagellum, which articulates upon the scape.

The mouth parts of the bee bear consideration in detail. There

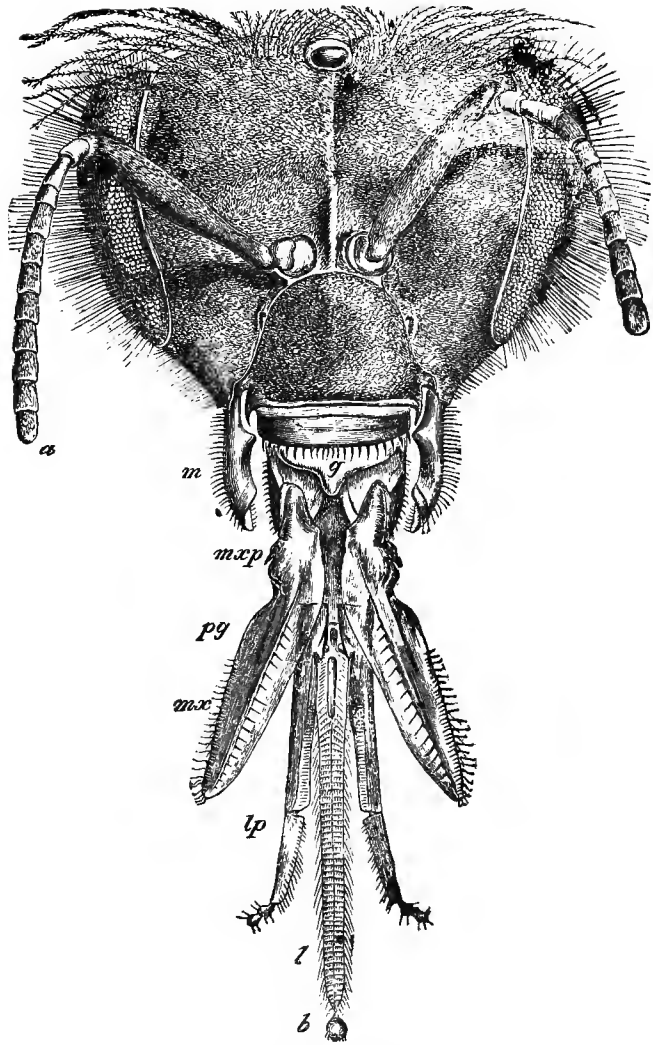


Fig. 2—Head and Tongue of Bee (magnified sixteen times.)
a, antenna, or feeler; m, mandible, or outer jaw; g, gum flap, or epipharynx; mxp, maxillary palpus; pg, paraglossa; mx, maxilla, or inner jaw; lp, labial palpus; 1, ligula. (From Cheshire by courtesy of L. Upcott Gill, London.)

is a central proboscis or tongue which is capable of being drawn in for about half its length, and then it is bent under and carried with the tip against the neck. The tongue proper of the proboscis has a groove down its length, in which operates a rod which raises the honey, chiefly by capillarity. The lower portion of the tongue is covered with a large number of gathering hairs, and at the tip is flattened out, forming a spoon known as the bouton. The proboscis has two pairs of appendages located, one of each, on either side of the tongue proper. These are known as the maxillary and labial palpi respectively, and are chiefly tactile organs assisting, presumably, in the gathering of honey. Structurally viewed the proboscis may be considered as the enlarged and modified labium or lower lip, also called the hypopharynx. The labrum or upper lip, also known as the epiphanynx, is present unmodified. The side jaws or mandibles are present and are modified, not for biting purposes, but to serve as paddles in the manipulation of the wax in comb-building and also in other work about the colony.

The glands for the secretion of wax are located on the under side of the abdomen, under the upper and covered portion of the abdominal plates. These horny plates of chitin, covered with branching hairs, overlap each other like the shingles of a house. It is on the upper portion of these plates, covered with the plates above, that the wax scales form and appear between the plates of segments, pushing out farther and farther as the process of secreting goes on. These scales are seized by the forceps of the hind leg, previously described, and passed forward by the other legs to the madibles where the wax is softened and worked until of the right condition for building purposes.

Structurally considered the stinger of a bee is a modified ovipositor. In the case of the queen bee, its principal service is in the deposition of eggs and in the drone or male bee it is absent. In the worker or undeveloped female, as will appear later, it is modified for defensive purposes and provided with poison, chiefly formic acid, for injection into wounds inflicted. The stinger proper consists of two darts barbed at the ends. In the act of stinging these darts are alternately thrust outward and inward by complex muscular action, thus resulting in the deeper insertion of the sting. The poison is the product of a pair of glands in the ventral portion of the abdomen and is stored in a sack from which it is conducted by

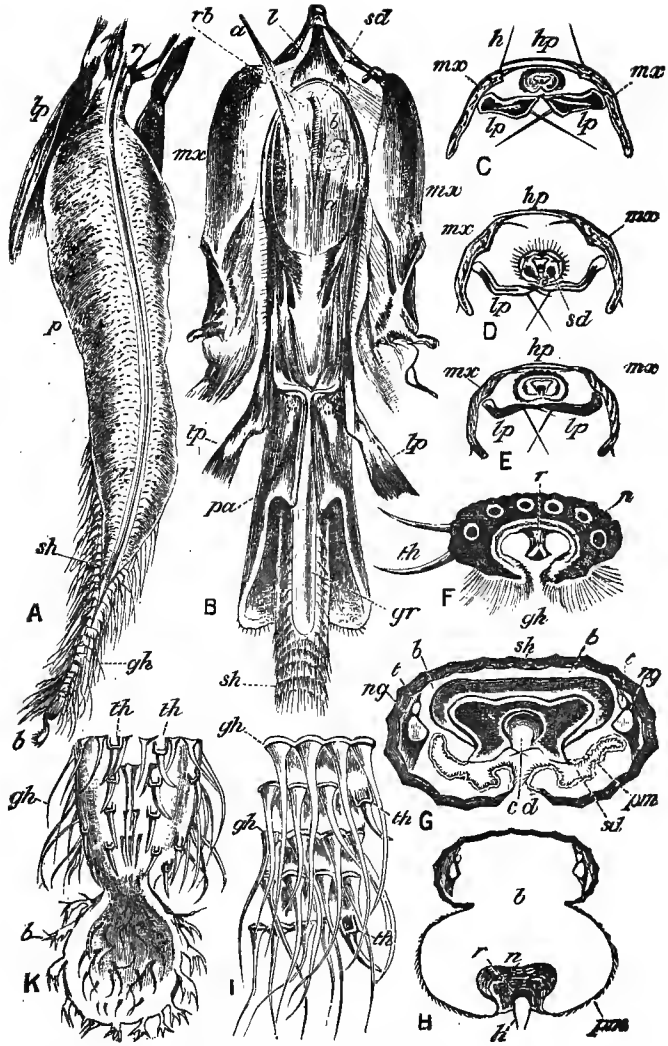


Fig. 3.—Details of Tongue Structures of Bee.
A, Under side of ligula; lp, labial palpus; r, r, rod; p, pouch; sh, sheath; gh, gathering hairs; b, bouton, or spoon. B. underlip or labium, with appendages, partly dissected—1, lora or submentum; a, a, retractor linguae longus; sr, salivavry duct; rb and b, retractor linguae biceps; mx, mx, maxillae; lp, lp libial palpi; pa, paraglossa; gr, feeding groove; sh, sheath of ligula. C, D, and E, cross sections of ligula; hp, hyaline plate of maxilla; h, hairs acting as stops; mx, maxillae; lp, labial palpi; sd, side duct. F, cross section of extremity of tongue, near spoon—th, tactile hairs; r, rod; n, nucleus; gh, gathering hairs. G, cross section of tonue without gathering hairs, magnified 400 times; sh, sheath; b, blood space; t, trachea; ng, gustatory nerve; cd, central duct; sd, side duct; pm, plaited mambrane. H, same as G, but magnified 200 times, and with pm, plaited membrane, turned outwards, as in A; b, blood; n, nucleus; r, rod; h, closing hairs. I small portion of sheath; gh, gathering hairs; th, tactile hairs. K, extemity of tongue with spoon, lettering as before; b, branching hairs for gagthering. (From Cheshire by courtesy of L. Upcott Gill, London).

ducts to minute openings opposite each barb, from which openings it passes and thus enters into the lowest portion of the wound. The honey bee usually inserting the stinger to its full depth is unable to extricate it, and so, in attempting to free itself, generally mutilates its body to such an extent that death ensues within a few hours. The stinger continues to act automatically for some moments after the first act of stinging and more poison is injected. Obviously, for this reason, the stinger should be removed as quickly as possible, and, since squeezing the stinger in an endeavor to pull it only introduces more poison, it should be removed by a scraping motion of the fingernail.

If we examine the sides of the abdomen of the bee we will find small oval openings, one to each segment, known as spiracles. These open into an elaborate series of tubular passage ways, known as tracheae, leading into the tracheoles, which ramify into every part of the body of the insect, carrying air to the most remote tissues. Circulation is accomplished through a dorsal blood vessel operating in lieu of a heart, driving the blood forward where it bathes the brain first and then gradually returns through the body cavity, entering the dorsal pericardial cavity through a series of openings. In a practical treatise of this kind we cannot go into the details of those portions of the anatomy and physiology of the bee, however interesting and wonderful they may be, which do not bear directly upon some practical feature, and for this reason we must pass rapidly over the internal anatomy. Suffice it to say in connection with the nervous system, that there is not a complete centralization of nervous control, as is the case in higher animals, but instead control is diffused among a series of ganglia occuring throughout the length of the body, explaining the striking performance of a decapitated bee running about for some time and even attempting to fly, after the head has been removed. There is, of course, a cephalic ganglion or brain which is more highly specialized than the others, for the reception of sensations and general control of the body.

We will pass quickly over the digestive system, citing the most important structures. The honey sack deserves notice. This is located immediately preceding the stomach and is connected with the latter by a very complicated and interesting passage called the stomach mouth. This passage is composed of four lip-like sides,

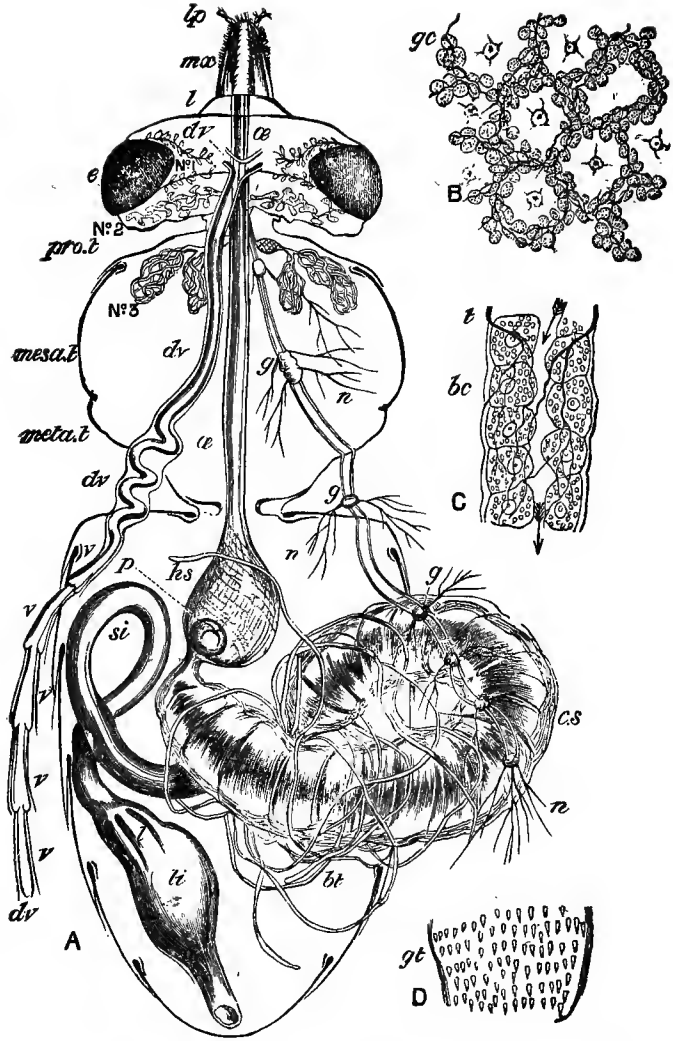


Fig. 4.—Digestive System of Bee (magnified ten times.)

A, Horizontal section of body; lp, labial palpus; mx, maxilla; e, eye; dv, dv, dorsal vessel; v, ventricles of the same; No. 1, No. 2, No. 3, salivary gland systems, 1, 2, 3; ae, oesophagus; pro. t, prothorax; mesa. t, mesathorax; meta. t, metathorax; g, g, ganglia of chief nerve chain; n, nerves; hs, honey sac; p, petaloid stopper of honey sac or stomach-mouth; c. s, chyle stomach; ht, biliary or malpighian vessels; si, small intestine; 1, lamellae or gland plates of colon; li, large intestine. B, cellular layer of stomach; gc, gastric cells, magnified 200 times. C, biliary tube—bc, bile cells; t, trachea. D, inner layer, carrying gt, gastric teeth. (From Cheshire by courtesy of L. Upcott Gill, London.

lined with setae or bristle-like hairs, and leading into a tube entering into the center of the chyle stomach or stomach proper. The functions of this passage as faithfully worked out by Professor Cheshire, are three; first, it enables the bee to pass on for digestion and assimilation honey and the pollen grains usually to be found in flower nectar; second, to deposite this food, especially the pollen grains, in the midst of the digestive fluids to so prevent any clogging; and third, it enables the bee to allow honey, with its contained pollen grains, to pass into the tube and return again through the hairs of the passage way, straining out the pollen grains, which pass into the stomach and are used by the bee for food. This can be accomplished by the bee while flying from flower to flower, gathering its sweets, so that when ready to return to the hive with its load, the pollen has all been removed and the honey is ready to be deposited in its cells, free from pollen, which might cause it to ferment. The stomach proper is provided with the usual glands necessary for the digestive function. The intestine is provided with a series of chitinous teeth, thus giving the structure the nature of a gizzard.

There remain a few words to be said relative to the important sets of glands located in and near the head. One pair of the glands is found trained about the optic ganglion and empties into ducts leading to the mouth, where the final duct empties. In the back of the head is a second pair of glands, and in the fore part of the thorax a third pair, these two sets emptying into the groove in the proboscis when the latter is extended for sucking purposes. To these glands there is ascribed digestive functions among which is changing the cane sugar of the flower nectar into the grape sugar of honey. The first set of glands is found largely developed in the young workers and not present at all in the best queens and in the drones. The function of feeding the young larva in its early stages is assigned to the first pair of glands.

As in other animals, the reproductive organs of the male bee consist of a pair of tests located in the abdomen. Here the spermatozoa are developed and passed through the tubes leading outward to the vasa deferentia, which unite, forming the ejaculatory duct. Just before the entrance into the ejaculatory duct there is an enlargement of the vas deferens into a well defined seminal sack or resting place for the spermatozoa. Here the latter are kept free and alive by the addition of mucus from connecting glands. Pass-

ing on through the ejaculator duct, the seminal fluid is stored away in the spermatophore, a sack or pouch-like enlargement, the contents of which, at the time of copulation with the female, is transfered to the female, thereafter being essential to her reproductive function.

In the female the ova are developed in the two ovaries and

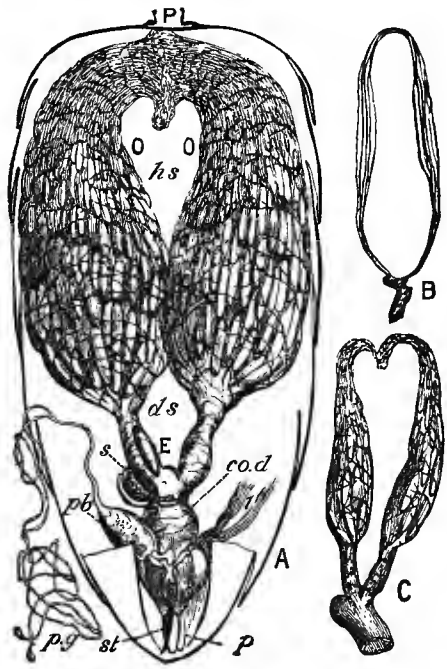


Fig. 5—Ovaries of Queen, etc.

A, Abdomen of queen, under side (magnified eight times)—P, petiole; O, O, ovaries; hs, position filled by honey sac; ds, position through which digestive system passes; od, oviduct; co. d, common oviduct; E, egg-passing oviduct; s, spermatheca; i, intestine; pb, poison bag; p. g., poison gland; st., sting; p, palpi. B, rudimentary ovaries of ordinary worker—sp, rudimentary spermatheca. C, partially developed ovaries of fertile worker—sp, rudimentary spermatheca. (From Cheshire by courtesy of L. Upcott Gill, London.)

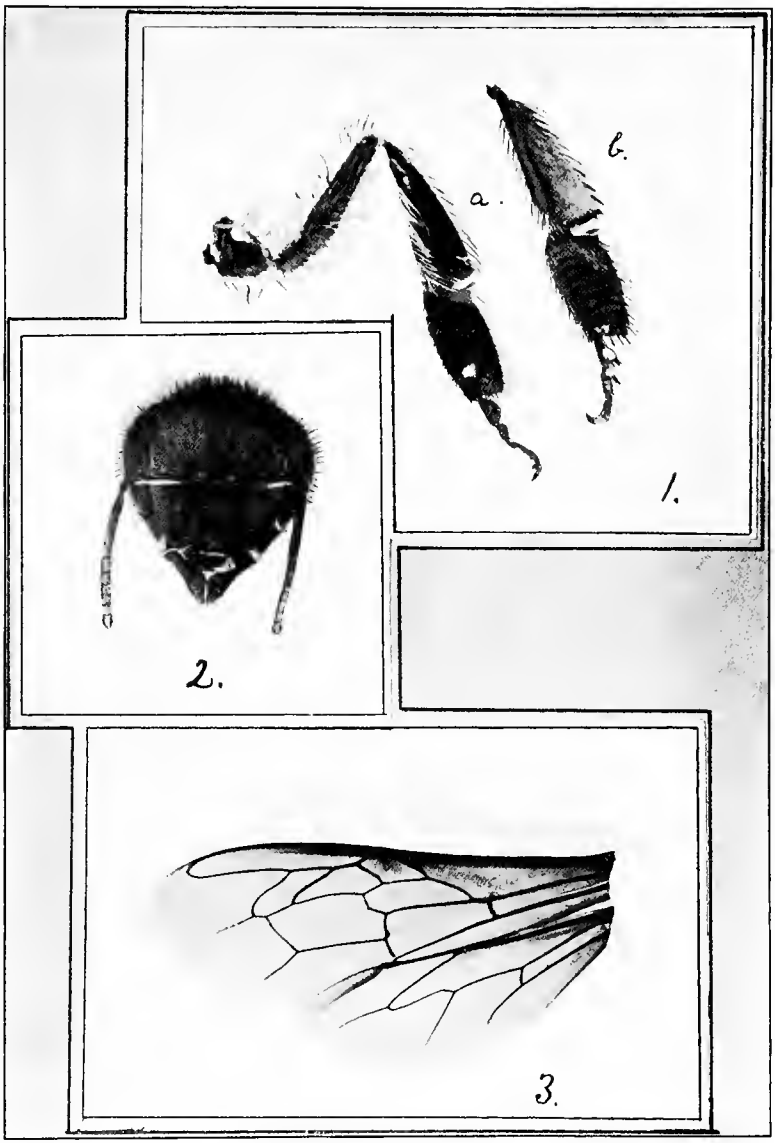
pass down the fallopian tubes, or oviducts, to the vagina. Here the ova are fertilized from the spermatheca, where the spermatozoa from the male or drone bee have been deposited. At this time the egg is well formed and has a shell, and the sperm enters through a

small opening, the micropyle. Fertilization is accomplished at will, male bees being produced from unfertilized eggs.

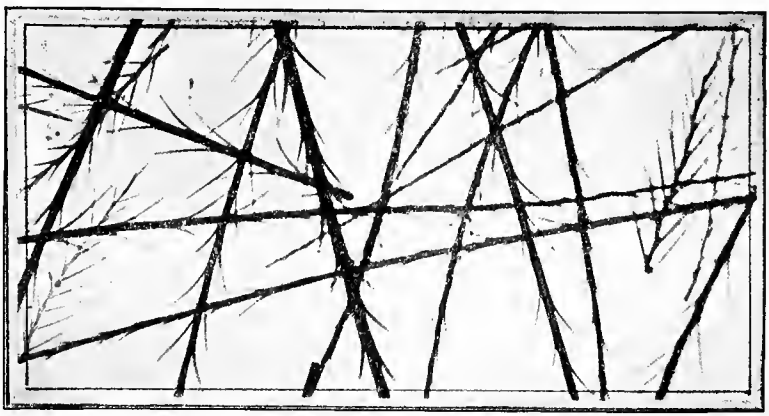
SOME HABITS OF THE BEES.

We are all familiar with the sight of bees flying from flower to flower, now dusted with pollen and stopping to brush themselves with their legs and pack away the golden treasure in their sacks, now scrambling into deep flowers or clinging in twisted and contorted positions to extract the sweets of some drooping flower. We find that we can chase these industrious little fellows, shake the flowers, and even attempt to catch them, and still no resentment or attempt to sting on the part of our little companions. They seem to realize the neutrality of the ground and only skillfully evade our efforts, flying off with a confident hum to some distant flower to continue their busy work. Not so when we stumble upon their homes in hollow trees or about the eaves of the barn or perhaps the house, or out in the orchard where the bee homes devised by man for his own convenience are inhabited by numbers of these insects. Intrusion here in the sacred precincts of the home are at once resented as many of us have no doubt discovered. But cautiously drawing close many things of interest can be noted by watching the little creatures as they ply their busy way to and from the entrance to the colony.

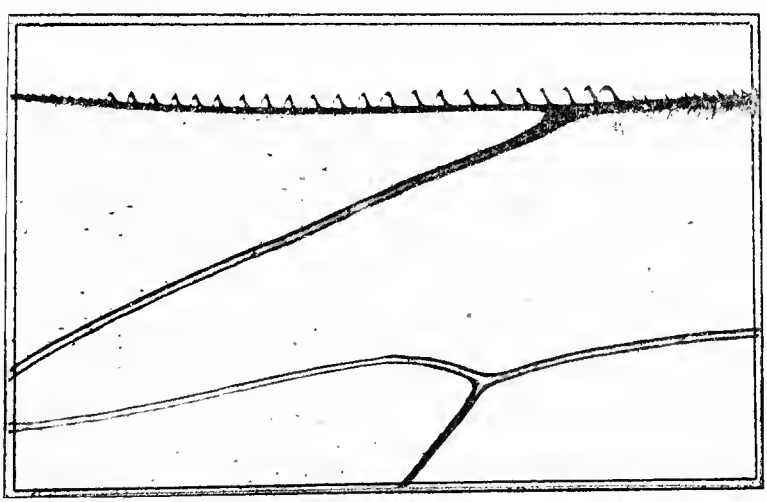
The heavy laden bees come down flying low and slowly, with a dull resonant hum, dropping wearily on the alighting board like pelting snow. As they crawl toward the entrance they are immediately met by one or more bees which are always on the alert, accosting each incomer. Satisfied that the intrant is of the colony—for each bee belongs to a particular colony, and each bee knows the bees of its own colony, presumably by scent,—it passes in to unload. Meanwhile other bees are passing out. They come out with a quick run. Perhaps at first they seem unable to rise. This is due to the fact that the air sacks contained in the abdomen are not inflated, but these are soon filled through the spiracles of the sides, and the bee rises and flies high into the air. If there is no main harvest of honey on, the bee will be seen perhaps to describe one or two circles and then start off like an arrow. But if honey is to be had in abundance in a particular direction, the bees pass out and with a dart in the given direction are lost in the air above. In



1a, view of outside of hind leg of worker bee; 1b, view of inside of same; 2, view of head of worker bee from the front; 3, left wings of worker bee extended as for flight. (Photographs by R. A. Cooley.)



Photomicrograph of hairs from a honey bee. (Photograph by R. A. Cooley.)



Edge of hind wing of bee showing hooks by which the two wings are attached. (Photograph by R. A. Cooley.)

their haste they fly in zig-zag darts and with a clear ringing note.

Watching the bees thus we may occasionally hear a coarse buzzing note and a larger and more clumsy bee will drop down on the alighting board. These are the males or drone bees, and are so named because they are bees of leisure, never working in the field or in the colony. If it should happen to be about two or three in the afternoon of a bright spring day, we may witness a very interesting exercise which at first, to the novice, may be mistaken for the issuing of the proverbial swarm. Suddenly numbers of bees will rush out quite excitedly and with their heads toward the colony will actively fly in ever increasing semicircles. These are the young bees taking their daily flight to gain deftness in the handling of their wings, and also to mark the location of the colony, so that later they can easily find it when returning from the field with stores, for the work of gathering honey and pollen, is done by the older bees. At present these young bees are serving an apprenticeship in the hives as nurses, and this flight is their daily exercise and recreation from their busy life indoors. Their flight lasts usually about twenty minutes, and then all is quiet again, except for the dull hum of the incoming bees laden with their stores. Occasionally the monotony may be broken by the excitement of repelling an invader in the shape of a bee from another colony, or an intrusion by some other insect, a wasp or an ant, perhaps. These invaders are taken care of by the guards already spoken of, and being dragged to the edge of the alighting board, are set free. These stray bees we call robbers, as they go from hive to hive seeking to get admission for the purpose of stealing. They are not unusually shiny black, as the coat of hair has been worn off by the many encounters they have experienced.

If we observe closely we may see a number of dead bees on the ground, especially if it is early in the spring, as the death rate of old bees is very great at that time of the year. We may happen to see a couple of bees come out tugging at a corpse to get it out of the colony. Successful in getting a good hold, one of the bees, having gotten the burden close to the edge of the alighting board, will rise in the air and fly slowly away, dropping its burden some yards from the colony, for the bees are very mindful of the cleanliness of their habitation.

Getting somewhat bolder, we may come close to the entrance

of the colony and by placing the fingers near the entrance, we can feel a current of air being driven in and out of the colony. This is done by the buzzing of a chain of bees through the colony, and so a perfect system of ventilation is kept up. If the bees are gathering honey rapidly we may observe a sickish sweet odor of new honey and hear, especially at night, a continuous roar. These are the bees, who, having toiled all day in the harvest fields, spend the hours of night driving a current of air through the hive to evaporate the new honey, for the nectar as gathered has a large percentage of water in it, which must be removed. An interesting experiment was run once with a hive on the scales and a record of the weight made each evening and morning, with the result of a decrease in the gross increase of the day before of about a third, due to evaporation of water.

With these few outward observations let us open the colony and learn something of the economy of the home life. The combs are built vertical and parallel, suspended from above and running from front to rear. Cells of four kinds are distinguishable. By far the larger number of these are the worker cells. The honey cells are of the same basal size, but are slanted upward, and so the opening is somewhat distorted. The drone cells are larger and not so numerous. The queen cells, though only present at certain times in full size, are usually to be found as mere basal cells or cups placed along the edges of the combs or any projection of the combs. The brood is normally confined to the lower, central and front portions of the combs,—that is, in the vicinity of the entrance. Above, to the rear and at the sides, are cells containing pollen, and outside of the pollen circle the honey is stored. So that a vertical, longitudinal section through the colony would show the honey stored above and to the rear, next inside a few cells of pollen, and then the brood. The queen in starting brood in an unoccupied comb, first deposits eggs in the center of the brood portion of the comb, and as she continues uses the comb in increasing circles. Thus the oldest brood may be found in the center, the younger brood on the outside and the eggs on the outermost edge. However, when the brood in the center has matured and emerged it is replaced by eggs for a second brood.

The queen bee lays all the eggs,—fertilized eggs producing females and unfertilized eggs, males. The females are of two kinds,

those fully developed for reproduction, and known as the queens, and those whose reproductive organs are undeveloped, but which are more highly developed along other lines and which serve as the laborers of the colony and are called workers. The males are the drones and do no work, but they are absolutely necessary in any apiary unless fertilized queens are to be continually introduced as needed from some other apiary. An ordinary colony will have one queen, two to three hundred drones, and twenty to thirty thousand workers.

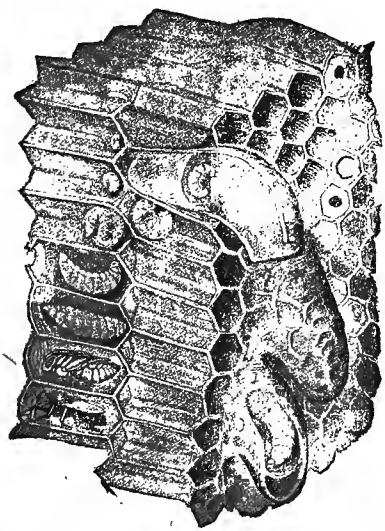


Fig. 6.—Queen cells and worker brood in various stages (Benton, Manual of the Honey Bee, U. S. Department of Agriculture.)

We have said that the queens and workers come alike from the fertilized eggs. The difference in development is due to the character and amount of food supplied the growing larvae. The time spent in the egg stage after deposition is alike for all, three days. The eggs then hatch into small white grubs or larvae and remain in this stage five and a half days for the queen, or five days for the worker. For the first three days the larvae are fed the secretion from the glands of the head of the nurse bees (young bees less than two weeks old in general.) Then the worker larvae are fed on honey and later pollen until the pupa state of thirteen days. The larva des-

tined to become a queen, however, is continued upon this glandular secretion or royal jelly, as it is called, and the cell enlarged and built down to permit the proper growth of the inmate. A large quantity of the royal jelly is then deposited in the cell and the cell is sealed up. In seven days, under this rich food the queen emerges. After several days, usually not longer than a week, the young virgin queen flies out to meet the drone and returns fertilized for life and soon begins to deposit eggs.

The male or drone bees, as has been said, come from unfertilized eggs and so can be produced by a virgin queen or at will by a fertilized queen. The egg hatches in three days and, after three days of feeding upon the royal jelly, the larva is fed honey and pollen for three more days when it pupates. After fifteen days in the quiescent or pupal stage the grown bee emerges. Drones are usually only to be found during the spring and early summer months when there are young queens to be fertilized. Late in the summer, when the honey harvest wanes, the workers drive out the proverbially lazy drones and worry and starve them to death.

It is not to be inferred from the fact of the workers being classed as undeveloped females, that they are in any sense, except in reproductive powers, the inferior of the queen. In fact, they are much more highly developed in almost all other directions, of necessity, in order to perform their manifold duties. The drones are believed to excel the queen in powers of sight and scent. This is found to be in keeping with the fact that they have to seek out the virgin queens upon their bridal flight.

Each colony normally swarms each spring. Queen cells are started as described, usually about a dozen or so according to the strength of the colony. When the first cell is sealed, the swarm composed of all the bees that can fly, together with the old queen, issue forth. This usually takes place between nine o'clock and noon, a swarm rarely issuing after one o'clock unless unfavorable weather has kept the bees in. Just previous to swarming the bees gorge themselves with honey and are not inclined in the least to sting. The swarming note is a peculiar resonant one and, if there are any other colonies in the vicinity ready to swarm, they are liable to take up the note, and running excitedly about the entrance, begin to pile out like beans poured from a peck measure. After circling about in the air a very few minutes, the queen lights and the bees

cluster very rapidly and are soon quiet. A little later bees will be seen flying to and from the cluster which are termed scouts. They are out looking for a new home. When a suitable place for a new home is reported, usually within a couple of hours, the cluster dissolves and the bees ,flying high, move very rapidly in the direction of the hollow tree or other place selected. The bees, having previously gorged themselves with honey and soon secreting wax, and, clustering in vertical chains forming a net-work, soon have the new combs started and the gathering of honey and pollen and the deposition of eggs underway.

If the parent colony is strong enough, a week later, when the first young queen comes out, a second swarm may be cast and then a third and even a fourth, in some instances. Finally one of the young queens takes possession of the colony and the bees destroy the other queens by cutting into the tender sides of the cells, dragging the queen out and throwing her out, dead. A peculiar note is sounded by the young queens in a hive when loose and when other queens are being held in the cells by the bees, as is sometimes the case. This note is called piping, and is indicative of the queen's distress and excitement. She will, from time to time, cling closely to the comb and, after issuing her plaintive note, rush about excitedly. If permitted by the bees, she will get at the cells and destroy the other queens.

After the queen has mated, the worker bees in their excitement will sometimes pitch upon her and form a ball. This is called "balling" a queen. The same thing may take place if two or more swarms get united, or if strange queens get into a colony. Should a colony thus destroy its queen or become queenless in any other way, the bees, on being disturbed, will set up a characteristic roar. The individual bees will buzz excitedly and then stop for an instant and then buzz again. This roaring is almost a positive evidence of the colony's queenless condition. Should the colony not have any eggs, or larvae under three days old, a queen cannot be produced by them. In the course of time the bees, realizing the hopelessly queenless condition, attempt, by feeding up worker bees, to regenerate the colony. These workers are termed laying workers and although their ovaries become filled with eggs, they are never capable of being fertilized, and so can produce nothing but drones of an inferior grade, as they are reared in worker cells. The food given

these laying workers is the royal jelly, believed to be fed queens not only during development but also during the egg laying season. Quite commonly queens will be seen to pass about the comb and be thus fed by workers. Workers themselves also, when filled with honey, will divide their stores with other bees, showing an interesting trait of extreme socialism.

For the winter the bees cluster compactly and quietly, thus retaining the heat generated by feeding upon honey. The queen ceases to lay, beginning again about February or March in this climate. Should any immovable object, like a snail or mouse, get into the hive and die, the bees, realizing their inability to move the burden will coat it over with propolis, a sticky substance gathered from bursting buds in the spring and summer and carried in the same manner as pollen on the legs. This substance is used to fill up all crevices and to close all openings against cold weather, as well as to serve the immediate function of securing all movable objects in the hive.

If the bees are angered they emit a sharp shrill note and fly excitedly in jerks. The experienced bee keeper learns to recognize all the various notes of his bees. Even when somewhat enraged the average bee hesitates to use her sting and will often crawl about after lighting, her courage seeming to fail her at the last moment. The bee also has a characteristic note of joy, which can be noticed when a cluster of tired bees are permitted to crawl into a colony. It is a resonant steady buzz, of medium pitch, not unlike the note emitted when ripening honey yet of a higher pitch.

VARIETIES OF BEES AND THEIR GEOGRAPHICAL DIVISION

Having become somewhat familiar with the structure and some of the habits of bees, we will now consider some of the special characteristics of the various races of bees and the geographical distribution of the several races. There are no native honey bees of America, the first colony having been brought, it is believed, to Georgia in the seventeenth century. Bees have steadily moved westward and were considered by the Indians as the fore-runners of the white man. The most common bees now are those commonly spoken of as hybrids. These are German or Black bees mixed with Italians.

The German or black or brown bees, as they are sometimes

called, are small and black in color. They are very excitable and cross, attacking passers-by at some distance from the colonies. They are very difficult and unsatisfactory to handle because of their tendency to run from the combs and drop off in great bunches, making it very difficult to find their queen. They are great propolizers and so stick everything fast, and hence are very hard to manipulate. They do not cluster in winter very well and are slow to build up in the spring. They are, however, fair honey producers, capping their honey very evenly, with nice white caps. They are more prone to rob than other bees, and at the least slackening in the honey harvest, will stop brood rearing.

Italian bees were first imported in 1860 and since then have become quite generally distributed. The American type, through a long process of selection, has changed to a golden yellow, often with five full bands somewhat in contrast to the leathery natives of Italy. These bees are larger than the blacks and much gentler, remaining quietly on the combs when opened. They do not exhibit those pernicious traits of the black bee, of flying out and attacking one on approaching the colony. The queens are more prolific, still the colonies after the long winter months are inclined to dwindle and not build up rapidly. This poor wintering may be due somewhat to the fact that Italy has a mild winter climate and early spring, and the bees have become accustomed to this environment and find it hard to adjust themselves to our rigorous northern climate.

Cyprians were the next kind introduced, being brought over in 1880. These bees are of a light yellow color, very active and make a good showing by their active movements as they fly in the sunlight in front of their hives. They are somewhat smaller than the Italians and have more pointed bodies, and their distinguishing mark is a bright yellow shield or half moon on the thorax, between the hind wings. The Cyprians are very prolific and winter well. They are most excellent honey gatherers, having the longest tongues of any honey bees, yet they fill their honey cells so full before capping that a watery appearance is given the combs, and so are not the best bees for the production of comb honey. They remain on the combs like Italians, yet can be very easily shaken like the blacks. They do not habitually attack passers-by, yet when once aroused, are liable to remain angry for a larger time. They are very excitable and resent jarring or the letting of light into their hives

suddenly. They cannot be quelled by smoke like other bees, but when smoked a little, respond well. If smoked too much, they stand and sizzle, and as soon as the smoke clears away, retaliate with vigor.

Closely related to the Cyprians, exhibiting many of their traits, are the Syrians, found on the mainland from Cyprus and north of Mt. Carmel. They are not as constant a race showing greater variation in markings and temperament. They begin to show the gray of the bees found a little farther north. The queens are larger than Cyprians, yet not so active. South of Mt. Carmel are found the Palestine or Holy Land bees. These bees again exhibit the trait of running from the combs and, even more, will run upon the hands and bite viciously like ants, which, it is to be remembered, are near relatives of bees. They show less yellow, and are inclined to rob. They produce fertile workers, and are very poor winterers. They are nearly as difficult to handle as Egyptians, which resemble them in many points. They are, however, good honey gatherers and quite prolific. The Persian bees are, in general, very similar to the preceding Oriental races described. The Tunisian, sometimes called Punicebees, are not unlike this general Oriental type. They are perhaps the greatest propolis gatherers of all bees. Coming northward again we may cite the Dalmatian bees found on the eastern shores of the Adriatic. Several attempts at importing these bees have failed. There appear, from reports, to be two varieties, one yellow and one gray, which will be seen to be true of several races and so not such a striking thing as at first it would seem to be.

Closely following the importation of the Cyprian and other Oriental bees came the importation of the Carniolans, from the small province of Carniola, in the southern part of Austria. Coming from the Carnic Alps, these bees are found to be the best winterers for our northern climate. They are, with perhaps one exception the gentlest bees known. The queens are quite prolific and the colonies, in contrast to the Italians, build up very rapidly in the early spring. There has been some objection raised to the fact that they swarm excessively. This is probably due to the fact that, when first introduced, beekeepers were used to the spring dwindling of Italians, and so governed accordingly and crowded the prolific Carniolans in the early spring, resulting in the casting of early and numerous swarms. If these bees be given plenty of room and

ventilation, swarming is found to be no more prevalent among them than among other bees of prolific character. The workers are larger than most bees and are strong flyers and good honey gatherers, of a dusty gray appearance, caused by gray hairs in well defined rings on the abdomen. The drones are the largest of any honey bees and of a grayish color. The queens are large and vary from light leathery color to an almost bronze black. The Carniolans gather the least propolis of any known bees. They can be easily handled at night, not flying and crawling as most bees do. When handled in the daytime they remain quietly on the combs and the rare spectacle of a queen quietly laying eggs while the hive is open has been observed on a comb, so unconcerned are the bees.

Another strain of bees recently brought to the notice of the beekeeping world, yet not extensively imported, are the Banater bees of Hungary. These bees resemble in appearance the Carniolans but are smaller and not quite so gray, there being more of a tendency to show yellow. It is said by Hungarian beekeepers that they have no trouble from excessive swarming with their bees, and that the Banater bees are prolific and good honey gatherers. Farther east, over in the Siebenberg region, more yellow is noticed in the markings. This is true as one journeys southeastward through Servia, Roumellia into Turkey. The writer also noticed a steady increase of excitability shading off into the very excitable bees of the Orient.

Continuing the belt of gray bees of Carniola and Hungary are the Caucasians found in the province of Caucasus, in the region of Southern Russia, between the Black Sea and the Caspian Sea. These bees are smaller even than the Banater bees, with more pointed bodies, and even more dusty gray than the Carniolans. They rival the Carniolans in gentleness of temperament and perhaps are the most gentle bees yet known to the world. So very pronounced is this characteristic that they have been popularly called stingless, although they have well developed stingers and can be provoked to use them occasionally. These bees are being imported quite extensively and seem to give general satisfaction wherever introduced. Toward the south the yellow type begins to appear, bearing out the general tendency noticed in the other bees of central Europe, already discussed.

In general it will be noticed that the bees of north Europe are

black, cross and poor winterers. South of these is a belt of gray, gentle bees,—the Carniolans, Dalmatians, Banaters, and Caucasians. Farther south all of these races are increasingly yellow and have their gentle temperaments somewhat modified. South of this belt is a yellow belt, closely typified by the Italians and the Cyprians. East and to the south again are found cross, propolis gathering, and very excitable bees, the extreme types being the Egyptians and the Tunisians.

There remains yet to be discussed a very successful bee produced by crossing and known as the Cyprio-Carniolan bees. This cross is made by mating daughters of pure Cyprian queens to drones of Carniolan blood. It has been found that the male bee carries the temperament and the queen bee the honey gathering and the prolific characteristics. This cross unites the desirable qualities of the Carniolans with the great prolific and honey gatherng powers of the Cyprians, and thus produces a strain most valuable from a commercial standpoint. A practical difficulty in growing these bees is that the type has not been established, and breeding from the second generation and the third generation results disastrously, in that the progeny revert to the original characters and do not breed true. This necessitates continuous breeding from pure stock.

BEES AND FLOWERS—HONEY PRODUCING PLANTS

One of the most fascinating things in nature is the study of the inter-dependence of flowers and insects, more especially the bees. How many of us in our daily rounds stop to think why all the unfolding of beauty displayed by the little flower at our feet? Why these bright variegated colors and all this fragrance and these stores of sweets? Is it a startling statement to say that these things displayed by the flower, that this banquet spread, are for the insects, —for the humming bees that pass by unheeded or shunned by the majority of us all? How we may well envy the little busy fellows as they musically ply their way, flying from place to place on the bright spring days, in among these gorgeous flowers!

Ecology, the science of the relation of insects to their environment, and botany tell us that the flowers through a long process of natural selection, have developed these bright colors for the purpose of attracting insect visitors which, in turn, render the flower a valuable service as will be seen later. Many flowers in addition

to the bright colored corolla have also at the base of each petal a small vesicle called a nectary for the secretion of nectar. Leading to this nectary and converging toward it are often numerous dark or black lines which serve to guide the visiting bees to where they can secure the nectar. Every facility is thus tendered the bees in their quest for honey. To repay the flower for all its service, the bee renders in turn, an equivalent of far reaching magnitude. Firmly implanted throughout all nature is the instinct of self preservation and perpetuation by the introduction of new and undissipated vitality in reproduction. This law is so comprehensive as to include plants as well as animals. Before a seed can start its growth it must receive the impetus from the pollen laden stamen. In many flowers both the ovary, with its pistil, and the stamens, with their anthers filled with pollen, may be found. In a great many flowers where they both occur, however, the stamens are so placed that the pollen is not likely to come in contact with the pistil, and in some flowers this tendency to avoid self fertilization is further manifested by the stamens bearing their pollen at a different time than when the pistil is in a receptive condition for the pollen. In a number of trees, as for instance the common poplars, the staminate flowers are borne on separate trees from the pistillate, making self pollenation impossible. Still other trees, (e. g. among pears and in nearly all varieties of plum) while capable of being pollinated from their own stamens, are yet absolutely self sterile; that is, before fruit will set they must be supplied with pollen from a distinct horticultural variety.

In the chapter on the habits of bees, we noted that bees gathered pollen for the feeding of their young. It is a singular fact that a bee when out gathering a certain kind of pollen will always complete her load with the same kind of pollen and will never pass from one species to another; e. g. from poplar to a fruit tree or vice-versa. Nature's economy in this is self evident. As the bee flies from flower to flower she becomes dusted with pollen and in the course of her journey, an interchange of pollen is effected. It is plain that there would be no object in the interchange of pollen from two distinct species, as fertilization only in very rare instances, if ever, would result. To facilitate pollenation some flowers have become strikingly modified through natural selection. Let us say here that there can be no other purpose for the secretion of nectar

than to attract bees and other insects, and to secure cross fertilization. So the bee, not only when she is gathering pollen, but also when she is gathering honey, becomes the inadvertent agent of flowers in their cross pollenation.

On examining one of the so called papilionacious blossoms,—a pea for example—it will be noticed that the keel petals are rigid and that the bee, upon alighting upon the olae, depresses the latter and brings the style of the pistil in contact with the pollen laden hairs of the underside of the bee, resulting in fertilization. Then, as the bee advances and sips up the nectar, a fresh supply of pollen is gotten, which in turn serves to fertilize the next blossom visited.

For instances of these modifications the interested reader will have to refer to Darwin, and other writers, as we cannot here describe many of them. The famous orchid may, however, be cited here as an example of the employment of a mechanical device to insure cross fertilization. In the orchid there is but one anther, and this is so placed as to come in contact with the head of the bee when she enters the flower. The honey in the nectary is protected by a thin membrane, the irritation of which causes the rupturing of the membrane in such a way as to bring the anther cells in contact with a viscid surface and in turn with the head of the bee. As the bee remains an instant sipping up the nectar the anther has time to set and then the bee emerges bearing a structure resembling a couple of horns on her head. The weight of the anthers bends the appendage down so that, by the time the bee reaches the next flower, the anthers are in the right position to touch the stigmatic surface of the pistil and not be coincident with the anther of the flower visited.

With this brief discussion of the relation between bees and flowers we will pass to a consideration of some of the leading honey plants.

Among the first plants to bloom early in the spring are the willows. While affording little or no honey, willows are a great source of pollen, coming at just the time when it is most needed, when the bees are rearing brood and have many developing bees to feed. Dandelions produce pollen at this season and are frequented. Huckleberries are also visited by the bees as well as service berries and barberries. Along the creek bottoms and blossoming in May are many wild gooseberries from which a considerable yield of honey may be had. Fruit trees particularly apples, are now being

grown quite extensively in some parts of the state and afford a not unimportant source of honey of a fine flavor. All of these sources, however, come at a time to render them of not much consequence as sources of surplus honey. They serve, however, to build up the colonies for the more extensive yields which follow.

Usually by the time raspberries bloom the bees are quite strong and in localities where these are abundant, either in the mountain canyons or in districts where raspberries are grown extensively, honey of a very fine flavor may be obtained. Mints of all kinds are usually abundant honey yielders. The cleone or spider plant, found growing wild along the roads and popularly called, in Colorado, the Rocky Mountain bee plant, yields honey of a good quality.

By far the greatest yields of honey in the state come from the clovers. Chief among these is alsike clover, grown extensively for hay. This usually begins to bloom about the middle of June, in the Gallatin Valley, continuing until about the tenth of August. The main yield comes in July and we registered a gain of eleven pounds by an average colony in a single day,—giving a net gain of some six pounds after evaporation had been accomplished by the bees over night. Alsike clover honey is of a very light and clear grade, somewhat heavier than white clover,—that is, having more body.

Alfalfa, or lucern is an extensively grown forage crop and furnishes a light honey of a high grade. In some parts of the State this is the main yield and where three or four crops are had, if allowed to bloom well before cutting, can be made to last over a considerable portion of the summer. White clover is working in in the more settled valleys and is found along the road side, in the corners of fields and along the creek bottoms. Where white clover and alsike clover bloom at the same time the bees seem to show a decided preference for the latter. A striking instance was noted when the campus at the College was white with the blossoms of white clover one could cross it most anywhere and hardly find a bee upon it. About a quarter of a mile south of the campus there were some quite extensive fields of alsike clover and these were covered with bees flying clearly in the direction of the colonies on the station farm.

In some parts of the State, notably in the Flathead basin, there is a considerable yield of an amber colored honey of a muddy appearance from sweet clover or melilot. This clover is a biennial and grows to the height of four or five feet, blossoming the second

year. It is a plant which is easily scattered in a new territory and is found growing frequently along railroad tracks where it is brought in. In a few years it takes possession of the roadsides for several miles back from the railroad.

The lack of an autumn harvest is one of the most noticeable things in the State. There are many varieties of golden rod or solidago which serve to keep the colonies rearing brood but are not sufficient to afford stores for the winter. There are some plants which may be cultivated and incidentally increase the honey production. Among such plants may be cited Wagner's flat pea, vetches of various kinds and parsnips. In general there are few if any plants that can be cultivated for the honey they may produce unless they have some other value also.

ESSENTIALS OF A GOOD BEE HIVE

Nearly everyone is familiar with the pictures of the old conical bee hives of straw. These hives consisted of rings of straw bound together and shaped up like the crown of a hat, measuring perhaps eighteen to twenty inches in diameter, and a little more in height. At one point on the edge a piece was removed for an entrance, and then the whole inverted on a board. Rowed out in this fashion similar hives can be seen today in some parts of Germany and Austria. When one wished to remove the honey a bit of sulphur paper was burned in the entrance, killing the bees; then the combs of honey were removed. This method in these days would be exceedingly wasteful and very primitive. With the advance of apiculture, sulphuring is being relegated to the upper shelf and bees have increased greatly in value. In America the old box hive, on the same principal, was in vogue until the middle of the last century. These pioneer hives measured about fifteen inches square and usually stood about thirty inches high. As in the old straw hives, the entrance was formed by a notch in the edge of the hive which was then inverted on a bottom board, the latter projecting and forming the alighting board. To facilitate attachment of combs, a couple of sticks were sometimes crossed in the box near the top, upon which the bees could cluster for comb building.

The hive now commonly used in Germany, Northern Austria, German Switzerland, Italy and Hungary is the one improved by the Baron von Berlepsch and known by his name. This hive is arranged

to open by a door at the rear. The frames, made in varying dimensions, on the average perhaps twelve inches long by nine deep, are suspended from the top bars in tiers of a dozen or fifteen deep. These are sometimes three deep and the frames are removed by pliers. One advantage that this hive can have is that the brood combs below are at once available without removing the upper combs filled with honey. The slowness of the operation, however, and the trouble in seeking out a queen, more than outweighs this slight advantage.

In southern Austria where frame hives have not found a very ready acceptance, another hive is in vogue. This style has evolved from the custom of the beekeepers of migrating with their bees during the buckwheat honey harvest, this grain being grown as a staple crop in the larger valleys. The hives are not fitted with movable frames and the bees are allowed to build as they please. They measure about six inches high, twelve inches wide and thirty inches deep. The front is usually removable and the bottom is loosely attached. These flat hives can be loaded in numbers on a wagon in a very satisfactory way and are also adapted to being shipped by rail. They are tiered up with a roof over them thus protecting each other from inclement weather. The peasants are fond of depicting various scenes upon the fronts of their hives; Bible scenes having a prominent preference. One can trace sometimes the course of Biblical history in one of these old apiaries by the portrayal of well selected events.

In England, France and French Switzerland the movable frame hive, invented and perfected in America, is in common use. This invention, which revolutionized modern bee keeping, came out about the middle of the last century and was given to the beekeeping world by Rev. L. L. Langstroth. The distinctive feature of Mr. Langstroth's hive is the movable frame. In brief, the hive consists of a box somewhat longer than broad and still shallower, arranged so that a series of frames can be suspended in it running lengthwise, ten or twelve in number, the projecting ends of the top bars, resting on a rabbet on each end piece of the hive body. The final dimension of these frames, as settled upon by Mr. Langstroth is 17 5-8 inches in length, by 9 1-8 inches in depth, outside measurements. This frame has been universally adopted as the standard size. There are many honey producers who use a deeper frame with marked success, yet

nearly all the factories now turn out the standard size and bees in the market are usually discounted if in odd sized hives.

The Langstroth frame is usually made with the top bar one inch in width and 7-8 of an inch in thickness, to support the weight of the honey laden comb without sagging. The side bars may be a little narrower and of 1-4 inch strips. The bottom bars are usually much narrower—even down to 1-4 inch square—so that the frames can be removed without crushing or rolling bees against the adjoining combs. The top bars as now manufactured are made with a double slot on the lower side and each frame is provided with a triangular wedge so that the comb foundation can be wedged in securely. This simple method of fitting in foundation will be discussed more in detail later.

There have been various devices tried for spacing the individual frames. One widely used style is that known as the Hoffman self-spacing end bar. The end bars are made somewhat wider at the top so that they project beyond the top bar, and coming in touch with those of the adjoining frame, form a bee space of 3-8 of an inch, the space allowed everywhere where bees must pass. The objection to this frame is that the bees so propolize and build brace combs over them that they are very hard to break apart, and, when once apart, they have to be scraped before they will fit together again. They form bad places to crush bees when one is working hurriedly. Staple spacers have also been used. For the amateur some form of spacing is not a bad plan but soon one acquires the ability to place frames with the correct interval, and manipulation is much easier with no means of self spacing.

The ends of the hives are rabbeted so that the frames will have support. This in most instances, is made deeper than necessary to admit the top bar and still give the bee space and then a tin rabbet is inserted to minimize the effects of propolizing by the bees.

The hive bodies are cut to take eight, ten or twelve frames. Lock joints or halved joints nailed from each direction make a solid hive and are especially necessary if the bottom board is movable, as is the case with the common hives now in use. Where bees are wintered out of doors in this climate, some protection is necessary to retain the heat generated by the bees. This can be supplied by having a double-walled hive, with the space filled with chaff, straw, or paper, or ground cork, giving a few inches of dry absorbent ma-

terial all around the bees. In hives of this style it is better to have the bottoms permanently fast with packing on the bottom as well as on the sides. If single walled hives are used, winter cases may be set over them and packed as before. The matter of winter hives will receive fuller discussion in the section on wintering.

Above this lower story, designed chiefly for the brood rearing apartment of the colony and hereafter spoken of as the brood chamber, comes some sort of a structure for the storing of surplus honey. This may be another story similar to the lower one, when one wishes to secure extracted honey, or a half depth story, taking frames of just half the Langstroth depth, with thinner top bars. These are usually spoken of as top stories and may be tiered up to the number of three or four if the colony is strong enough. What is known as a super proper is a half depth story, fitted up with holders to the number of six, for an eight frame hive, or seven for a ten frame hive, each arranged to take four and sometimes, in the case of the deeper supers, five sections. Above the super or above the frames, when the super is not on, a sheet of enameled carriage cloth or oil-cloth, if placed with the glazed side down, will prevent the bees from sticking the cover down and, in the case of the super, will help to keep the sections clean.

The cover serves its purpose best if made with a gable, so that it will shed the water easily. Then is it easy to arrange for ventilation by having an auger hole in each gable end covered with wire cloth preferably. It is much more satisfactory to have a flat board surface down on the quilt so that, if the gable is boarded up, with auger holes in these boards covered with wire cloth, or left with cracks between the boards narrow enough to exclude the bees, a good system of ventilation can be had. Flat covers have been extensively used but this necessitates tipping the hives forward and also cuts off top ventilation. In the hottest weather the covers can be propped up and so increase the ventilation.

There are various styles of bottom boards, but the essential feature is to have a wide alighting board. It is well if, in addition to this, an additional board be provided and placed on an angle and reaching to the ground, so that the heavy laden and tired bees, as they drop down, will have no trouble to crawl up and into the hive. There should be some way of contracting the entrance so that, after the honey flow is over, the opening may be made smaller to guard

against robbing, or late in the fall, when cold nights begin to come on, it is well to close up a portion of the entrance to keep out the cold air. This may be accomplished by a couple of blocks which can be adjusted or by one piece with a smaller entrance or archway cut in it.

It will be seen that the essential features of a hive are very simple. With a simple hive manipulation is greatly enhanced, and in every way it is better to have as few contrivances about a hive as possible. There have been various plans to include in the construction of the hive a feeder, but no good device has been put in the field. Feeding is usually either accomplished from above, in an empty story, or at the entrance. It pays to nail hives well, and paint them well with a good grade of white lead. The covers may be even put together with white lead to insure tightness.

TECHNIQUE OF HANDLING BEES.

The art of handling bees cannot be learned out of books. The successful beemaster is only such by dint of the hard knocks in the school of experience. Yet there are a few points which, if kept in mind, will greatly lessen the number of mistakes and their consequences.

Fig 7—The Bingham Bee Smoker.

An essential implement in the handling of bees is a good bee smoker. There are several makes in the market. There seems to be none, however, which greatly excells the Bingham for all practical purposes. The mistake of getting too small a size is a common one, which results in trouble to light and keep a fire going. About a three inch barrel is the most convenient size. A fire may be lighted by twisting small bunches of excelsior into compact and

slender rolls and feeding them in gradually, lighting the first one before putting it in and keeping the bellows going lightly. When the smoker is warmed up, hard wood, split, may be added and later larger pieces until a good fire is started. Afterwards wood and excelsior may be added from time to time. Hard maple, well seasoned, or dead apple wood are the best fuel, as these woods do not gum up the smoker as do some others.

The beginner may find at first, until confidence is gained, that a bee veil will be a very desirable investment. Indeed there are few apiaries about which, at certain times, a veil will not be needed. A very durable one can be made from black cotton tule, with about eight or ten inches square of silk tule for the front, to better permit sight. The usual style is made open at top and bottom. The top is then gathered and a rubber band inserted, so that it will fit tightly over the crown of preferably a broad brimmed hat. The lower edge

Fig. 8.—The globe bee veil.

then can be tucked in the neck or folded under one's coat. The brim of the hat will hold the veil away from the face. There is offered for sale what is known as the globe bee veil, the essential feature of which is a pliable frame work skeleton which holds the veiling from the head at all points. It is somewhat inconvenient on account of the added weight. Rubber gloves can be worn but on the whole they are a useless article and are soon discarded even by the amateur.

A small sized putty knife or an old case knife, for scraping purposes, and a screw driver for prying the frames apart, together with a feather plucked from the left wing of a turkey and used for brushing the bees from the combs, equip one for opening a hive. It

is well to have a shallow tray or basket in which to carry these tools, some fuel, a couple of cans, one for propolis and the other for bits of wax, pencil and record cards, queen introducing cages, etc., at hand.

Passing to the windward side of a hive, with the smoker going well, the cover may be removed and stood down against the adjoining hive. Then pealing up one corner of the quilt, drive in just enough smoke to start the bees down. One should always be careful about placing anything, or standing, in front of the hive, as this obstructs the way and confuses the incoming bees and also prevents any bees that fly from the top from getting in again. For this same reason the practice of first blowing smoke in the entrance is not to be advised, though sometimes it becomes necessary. The smoker can be stood down to windward so that as the smoke rises it will be carried across the top of the hive keeping the bees down. Smoke is used to alarm the bees and set them feeding on honey. When filled with honey they become noticeably docile and can be handled with much greater ease and comfort.

Usually there will be more or less propolis on the top of the frames which may now be removed while the bees are filling themselves. Also there are quite likely to be brace combs built between the frames if the bees are gathering honey freely, and these may be cut out. In loosening the frames care should be taken not to jar the hive any more than necessary. In removing the first frame one must work slowly and with care lest bees be crushed and the anger of the colony aroused. In the eight frame hives there is room for what is known as a division board, the use of which is to give room to manipulate the frames upon its removal. In a good many instances, unless the bees are worked with quite frequently, the division board becomes so fastened that it is harder to remove than one of the frames. In the larger sized hives provision is not made for it.

One of the disadvantages of the self-spacing frames is that no working space can be had by shoving the frames together. One frame, having been removed and stood on end at one side of the hive, the others may be manipulated with ease.

There are four positions found to be of practical value when once learned, to facilitate the handling of frames of bees and honey. The first position is that in which the frame is in the hands when

first removed from the hive, with one hand at each end, the frame suspended vertically. In this position, which may be designated for convenience as number one, the near side of the comb can be observed. Raise the left hand until the frame is brought to a vertical position in the long way and take position two. Then whirl the frame around to the right until the far side is brought into view, keeping the combs vertical the whole time, and position number three is assumed. Then lower the left hand until the frame is again in its normal position, only inverted, and we have the opposite side before us. This is number four. In returning the frame the positions are gone through in the reverse sequence. It will be observed that the comb is kept vertical the whole time. The advantage of this is obvious. Freshly gathered honey is kept from dripping and newly built combs are kept from dropping out, as is likely to take place if the comb is allowed to come into a horizontal position.

If one is desirous of locating the queen it is obvious that the bees should be as little excited as possible. If the proper care be taken to secure these conditions a queen may be often found so undisturbed as to be quietly moving about the comb depositing eggs. The queen will be, under normal conditions, toward the center of the brood nest. She will not be found, as a rule, on frames of sealed brood or even on combs filled with larvae of an advanced stage, so that these may be passed by quickly. In general, it is best to take a quick look through a hive before spending much time looking each comb over systematically. When one is removing combs, as they are drawn out, sometimes a little excitement will be noticed on the comb in hand or the adjoining comb, signifying that the queen has been disturbed. It is upon combs containing eggs that the queen is most likely to be found. If the queen is a very old one, she will be sometimes found hovering about on the drone comb where her instinct leads her to deposit drone eggs, in view of the coming young queens. If she happens to be a young, unmated or virgin queen, it is almost useless to hunt for her because of her activity and similarity to the workers, in fact one has no clue as to her whereabouts since she is depositing no eggs.

In the course of opening colonies of bees and working with them it is often of advantage to change combs about, remove some, inserting others or sheets of foundation prepared ready for reception by

the bees. It will be remembered that, under natural conditions, the brood is centrally located, and to the front with scattering cells of pollen above and to the rear, followed by honey. The outside combs are nearly always given up to pollen in large quantities and to honey. In shifting combs in a colony care should be taken not to insert combs of this character from the outside into the middle of the brood nest, as this only divides the latter, and the bees will not move the pollen or sealed honey, even to give place for the queen to lay. The honey may be gotten rid of by first extracting, but the pollen still remains. Such combs of necessity must be kept for outside combs. Drone combs are also undesirable in the brood nest as they lead to the production of a large and super-abundant number of these fellows, which, not only take a great deal of the strength of the colony, in the shape of care during their development, but after being matured, are only so many extra and useless idlers to feed. In actual practice we try to expunge all drone combs from the brooder chamber. In any event, a patch of drone combs half as big as one's hand placed near the outside of the brood chamber will insure the rearing of all the drones necessary to fertilize virgin queens, for it must be kept in mind that a queen mates but once for life. It is also desirable to have only smooth, even combs, so that large patches of brood will be reared, for in broken combs the brood is patchy and much space is lost. Drone combs and uneven broken combs may, therefore, be gradually culled out and relegated to the top story and used for extracted honey. In removing such combs it is often hard to know just what to do with them, as they may have brood in them. If they be removed when placing a top story on they may then be simply set up, bees and all making sure that the queen is not on them. If the combs are to be removed entirely or placed in another hive the bees will have to be removed. This is accomplished by shaking, first taking the precaution to give the bees a whiff of the smoke. There are two ways of shaking. The comb may be raised from its position in the hive only far enough to clasp the hand vertically under the projecting ends of the top bar, and resting the hand on the edge of the hive, the comb may be shaken with a jarring motion by raising the hands slightly and returning them with force on the edge of the hives. The other way is to remove the comb entirely from its place, and holding it by the projecting ends of the top bar, raise it slowly until the bees

are braced on the combs against the rising movement, then lower the comb with a quick jerk and the bees will fall to the hive. This repeated several times will serve to get most of the bees off. The former mode of shaking is perhaps more desirable when there are young bees on the combs in any number, as these bees will then be shaken into the hive and not onto the ground as might be the case if the latter plan were followed. The latter plan is much more convenient and when the bees are old enough to fly, is entirely satisfactory. In either case the few bees remaining on the combs together with those that may re-alight may be removed by brushing them lightly either with a light brush made for the purpose or with a wing feather taken from a turkey or similar bird. This feather should be taken from the left wing as before noted, as this gives the curve in the right direction and the wide feather portion in contact with the comb for brushing when operated in the right hand.

But to return to the matter of manipulation of the combs of the brood chamber, in order to increase the brood area. To accomplish this successfully it takes judgment and experience. In general combs filled with brood,—i. e. eggs and young larvae,—may be moved toward the outside. Care should be taken, however, in a weak colony not to spread unsealed brood too much, especially early in the spring during cool weather. The combs with sealed or emerging brood may be placed next and then in or near the center, empty combs inserted for the queen to fill with eggs. The insertion of an empty comb in this way is a good plan to follow if one finds trouble, for any reason, in locating a queen. The next day the queen is almost sure to be caught on the inserted comb.

In inserting frames of full sheet comb foundation they should be placed between full combs so that there will not be too much vacant space in the center of the hive, as this may divide the brood nest. Again, if the starters only are used, i. e. narrow strips of foundation in the frames, placing the inserted frames thus, is more likely to insure getting straight and even combs. As a rule, it is best, however, to use full sheets of foundation and wire the frames as described in the section on Starting an Apiary. Starters may be used in second swarms or in colonies where there are young queens, as where there is an old queen there is a great tendency for the bees from instinct to build drone comb for the same reason that an old queen is found laying drone eggs. In a very strong colony, when

the queen is pressed for room, and the bees are not inclined to swarm, good worker combs may be built on starters even where an old queen is in the colony. By an old queen we mean any queen not of the current year's raising.

STARTING AN APIARY

In bee keeping, as in other enterprises, a good beginning contributes much to the ultimate success of the enterprise. For those who are inexperienced, this is doubly true. For the beginner, the spring of the year may be the best time to make the venture with bees. In our rigorous climate the matter of wintering bees is one which requires some little knowledge of bees, preferably at first hand. Thus, by starting in the spring, the beginner has the whole season before him and by fall has gained confidence and knows his little fellow laborers better and can better plan and provide for bringing them through the long and severe winter months. It is strongly to be recommended that for the beginner, the bees, if available, be of a gentle variety,—Carniolans or Italians, or possibly Caucasians, though the latter, being a newly imported variety, are not generally available. A good colony in the early spring should have a cluster covering at least six combs, and should have three or four frames of brood in various stages. There should be a supply of several pounds of honey, as, at this critical time, when there is much brood to be fed, and many hungry young bees emerging every day, honey is consumed rapidly and until the flow from early flowers equals the demand, the colony must depend upon its stores from the preceding year. The queen should be not older than from the preceding year's raising, though in the case of choice queens, a queen two and even three years of age may be retained. When thus kept it would be chiefly for breeding purposes. For reasons given previously, it is advisable to begin with a definite sized frame, and the Langstroth frame is now the generally accepted standard, except in certain restricted localities. Colonies having reasonably straight and even combs are to be preferred, as they are much easier of manipulation.

Having selected our stock, the next point is a suitable location for the apiary. Before starting an extensive apiary it would be well to look into the surrounding honey conditions, if honey production

is aimed at; or if queen rearing is to receive the main emphasis, it would be well to look up the bees of the locality and determine whether they would interfere with securing pure matings. The matter of bee diseases, while important in some states, is not at all to be feared in this state. It is well for the beginner to start modestly, with only one or two, or at the most, three or four hives, until a knowledge of the handling of bees is acquired. A few colonies will keep one quite busy learning, and if mistakes are made they are not of serious import financially. After one has learned the management of a small apiary it can be readily increased or added to until the number desired is reached. One person devoting all of his time, with proper facilities, can easily care for from one hundred and fifty to two hundred and fifty colonies. With the latter number help at certain seasons of the year might be needed.

In general a southern or southeastern exposure, on a gentle slope, is the best location for the colonies. A wind brake on the north and the west, in the nature of a building, high board fence or hedge, is an added advantage. A grass plot is good if the grass be kept cut, particularly in front of the hives, so that the bees are not hindered in their flight. The colonies should be placed several inches off the ground, on bricks or stones, or blocks of wood. The hives should stand level from side to side, but may slant a little to the front toward the entrance, to shed the water from the entrance. It is much more convenient if the hives be placed five or six feet apart, so that they can be easily worked without interfering with the adjoining colonies. They may be placed in rows breaking joints with each other and all facing in the same direction; or, as some do, they may be placed every two rows facing each other, giving an aisle or passage way through at the backs of the colonies. If quite a number of colonies are to be kept they should not be separated too much, as this entails too much lost labor and time in getting about and carrying honey laden combs. For this same reason the apiary should be placed as close as convenient to the room or building designed for use as a shop and honey house. Such a room, though not necessary for a few colonies, is a very desirable thing to have if available.

Having selected the site, the moving of the bees may be considered here. It may be that the frames in the hive will need wedging preparatory to being moved to prevent the combs from shifting

and crushing bees and perhaps breaking. The bees will have to be closed up at night, or early in the morning before they begin to fly. Over the top of the hive it is often well, if the hive is to go a considerable distance and the weather is warm, to tack a sheet of wire cloth, removing the cover temporarily. It may be even necessary in the case of very strong colonies, to take the added precaution of giving extra space above the frames in which the bees may cluster. This may be accomplished by placing an empty super above, placing the wire cloth above that. The entrance should also be covered with wire cloth for ventilation. If the hive has a movable bottom it will be necessary to make this secure. For this, crating staples are the most handy, though blocks of wood may be used. These fastenings would be suitable for securing the super where used as described above.

The hives thus prepared may be shipped by express. If to be removed by wagon, a spring wagon should be used, with straw or hay in the bottom. The hives should be placed with the combs running with the axle as then the force of the jolts does not strike the comb sideways, but on the edges in such a way that they can stand it better. It is better to move bees at night or early morning, so that they will be as cool as possible. Arriving at the new location of the apiary, the hives may be placed in position on the stands and with a lighted smoker the entrances may be opened. This is done first so that when the top packing is removed, the bees, flying out, will find their way in at the entrance without confusion. It is well, especially if the bees have been moved only a short distance, to slant a board in front of the entrance, so that they, on flying out the next morning, will have their attention called to the change in location and take notice of their new and strange surroundings. Otherwise they are liable to dart off from the hive as usual, and when ready to return home, will naturally go back to the old location and be lost. In a couple of days these boards may be removed and normal conditions restored.

Should the bees be purchased in the old style box hive, still commonly used among farmers, it might be desirable to transfer them into frame hives. This, however, should never be undertaken late in the fall, as the bees would not have time to recover from the disturbed condition of their house before winter. These operations should take place in the spring or early summer.

One word about preparing box hives for moving. They should be inverted, the bottom being movable, and wire cloth or cheese cloth tacked over the whole bottom. If there are any other openings these may be covered with wire cloth.

The box hive to be transferred is inverted and all openings or crevices except at the bottom now become the top closed. The frame hive or simply a box may then be placed over the open bottom and all openings boarded up. Then, by a light, rapid and continuous drumming, with a stick on the box hive, at first close to the ground and gradually higher, the bees may be driven into the box or hive on top. A little smoke blown in from the bottom close to the ground will serve to start the bees along a little more rapidly Too much smoke must not be given as this will only confuse the bees and perhaps even start them running back. In a short time the bees will have started as may be known by their loud buzzing. When they are all up, the hive or box may be removed and placed down upon the stand removing the box hive to a tent or closed room.

Here, away from any possible interference from robber bees, one may cut out the combs and fit them into frames. This should be done without much delay, as the brood should be restored to the warmth of the colony as soon as the change can be accomplished. To hold the combs in place, which should, of course, be fitted into the frames in their normal position, thin strips of wood may be used. Two of these strips notched at the ends, may be wired together at one end with space enough between to admit the frame and then after the insertion of the frame, with the comb in position, they may be wired above, and so a support for the comb is provided until the bees can fasten the combs in, which will be accomplished in the course of a very few days when the sticks may be removed. The sticks may be cut a little longer than the height of the frames and then placed in a slanting position, so that patched combs can be held in more efficiently. Two or three of these pairs of sticks may be necessary in order to hold the comb in place properly. Care should be taken in cutting the comb to have it fit close to the top-bar and when fiitted in, it should fill the frame so that it will be held closely fitting to the top-bar, and then the bees will secure it well and much quicker.

Another way of temporarily securing the combs and especially serviceable in the case of small pieces, is to use long, slender wire

nails. These may be pushed into the pieces of comb at intervals through holes made in the end or bottom bars. The nails may be removed afterwards or left in at will. Frames of comb, thus made up are patchy at best and after once having served their purpose they should be removed to the top story as extracting combs and gradually culled out for the wax extractor, and new combs built on foundation supplied to take their places in the brood chamber.

These frames of foundation are prepared in the following manner: The frames are placed upon a board arranged with another board above just the size of the inner dimensions of the frame, so that the frame will just fit down over it. This board should be just as thick as half the width of the end bars of the frame. If the frames are Hoffman self spacers, it will be necessary to slot the lower board to let the frame down flat, giving a place for the extra widened portion of the end bar.

With the frame in position four awl holes may be bored in each end at regular intervals, the first about an inch from the top bar and the last about the same distance from the bottom bar. These holes should be centered on the end bars. If, when the hives are purchased, the frames be ordered ready for wiring, they will come already pierced and a spool of wire included without extra charge. With the frame still on the form a tack may be placed near the top hole and one near the bottom hole. Then weaving the wire through, having placed the spool so it will revolve upon a peg or spike in the bench, the end of the wire may be secured around the lower tack and the tack driven in. Then the wire can be stretched up and, finally, by twisting the spool, be brought taught, the form preventing the frame from being pulled out of true. Then, after fastening the wire about the upper tack and driving this tack in, the wire may be twisted off and the frame removed ready for the foundation.

For fastening in the foundation, there are several styles of top bars. One formerly used was a bar with a single groove down the center. The foundation was inserted in the groove and then melted wax poured down it and allowed to cool. Another way was to have a beveled top bar in which the foundation was secured by being pressed into the wood by rubbing with the handle of a case knife wet so that the wax would not adhere to it. Care should be taken in this method not to wet the top bar, as the wax will not adhere to a wet surface. Still another form is that of a hollowed

tongue, similar to a hollow ground razor but broad at the base. Then the foundation is slit along one side to the depth of three-eights of an inch to half an inch at intervals of two or three inches and these pieces bent alternately up and down. Then placing the foundation in position in the frame the bent pieces will straddle the tongue and, by means of a dampened roller, the bent edges are rolled into the hollowed sides of the tongue, thus securing the sheet quite firmly in position.

A still commoner way and perhaps the quickest and easiest way, is to have a double groove in the top bar, one centrally located to receive the foundation and the other closely cut on one side of it. Then, by introducing a strip wedge triangularly shaped in cross section into the second groove and pressing it home the sheet of foundation is held quite firmly to the top bar.

The foundation having been secured along the top in one of these ways, the frame is returned to the form with the foundation on the underside of the wires. Then by running a spur wire embedder along the wires they are embedded in the wax and so form the desired support. Care must be exercised lest the foundation be cut by bearing too heavily upon the embedder. There are other forms of embedders and other methods of embedding. Where a large number of frames are to be prepared, for about five dollars an electric embedder, fitted up with batteries, can be purchased which works much more rapidly. But for the novice the first method with the spur embedder serves all practical purposes.

For fastening foundations into the sections in the supers fitted up for the production of comb honey different implements are used. The sections come commonly in one piece and are made of basswood so that they can be easily folded along transverse grooves into box

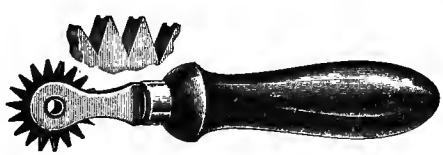


Fig. 9.—Spur wire embedder.

form and then fastened together by lock joints where the two ends meet. To fix this last joint and square the boxes up, what is known

as a section former is used, the essential feature of which is a form which can be brought firmly about the section by means of pressure. The sections thus prepared are ready for the foundation. The foundation used is of a much lighter grade than that used in the brood frames, so as to have as little midrib as possible in the comb honey, and comes in sheets half as wide and just long enough to be cut into four sheets the right size to go into the sections. For cutting foundation nothing is better than a slightly warmed or dampened thin case knife, though a thin roller knife is sometimes used. The sheets thus cut may be fitted in one of two ways,—by means of what is known as the Parker foundation fastener or by means of the Daisy fastener. The former works on the principal of pressing the foundation into the wood. The section is placed upside down upon the edge of the fastener which is made secure by screwing to a board or to the bench. The foundation is then laid flat upon the top piece of the section with the edge just a little beyond the middle of the section. Then by a biting motion the edge of the foundation is pressed into the wood and upon removing the section, the sheet is pressed into a vertical position and the section placed in the right position in the section holder in the super. The Daisy fastener is a little more complicated but works much faster and gives better satisfaction. It consists of a plate of metal which is heated by means of a lamp. The section is inverted and the foundation is held in position in the section but a little up from the top piece. By a pressing motion of the fastener

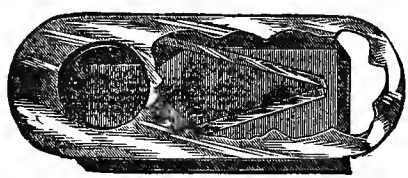


Fig. 10.—The Porter spring bee escape.

which is leaned against the bench, the heated plate is brought in contact with the edge of the foundation. In an instant the wax is melted and the plate allowed to fly back so that the sheet of foundation can be slipped down upon the section and allowed to cool. Care must be taken not to overheat the foundation or let the section get heated. The section may then be removed and placed

right side up in the super, the foundation becoming firmly fixed in a moment.

To remove the bees from the supers when the latter are filled with honey, a handy device known as the Porter bee escape has been provided. It consists of two springs so adjusted as to permit a bee to squeeze out but not to return,—operating in effect like a rat trap. This little tin device is fitted in the center of a honey board the size of the top of the hive and then slipped under the super the night before it is desired to remove the honey. Care should be taken not to smoke the bees much when removing comb honey as this alarms them and they bite into the white cappings and so cause the sections to run and drip afterwards. By morning the greater

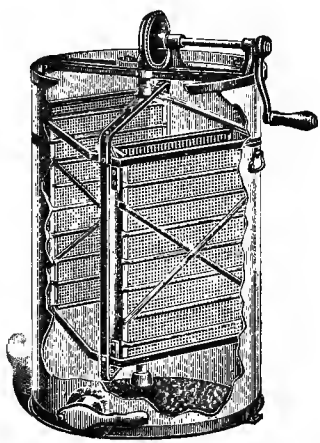


Fig. 11.—A rotary honey extractor.

part of the bees will be out and the sections can be easily taken away in the best of condition. The super should not be allowed to remain long on the hive after the bees have left it, if the weather is at all warm, as there is no ventilation after the bees are gone and the combs are likely to melt down and cause the honey to run. This same device may be used also with top stories but usually it goes much faster to brush the bees with full frames and it does not matter if the cappings are injured in this case. To keep the bees from returning to the combs as they are taken from the hive, the combs may be placed in what is known as a comb bucket. This bucket is made of tin with a cover and arranged to carry four or five combs

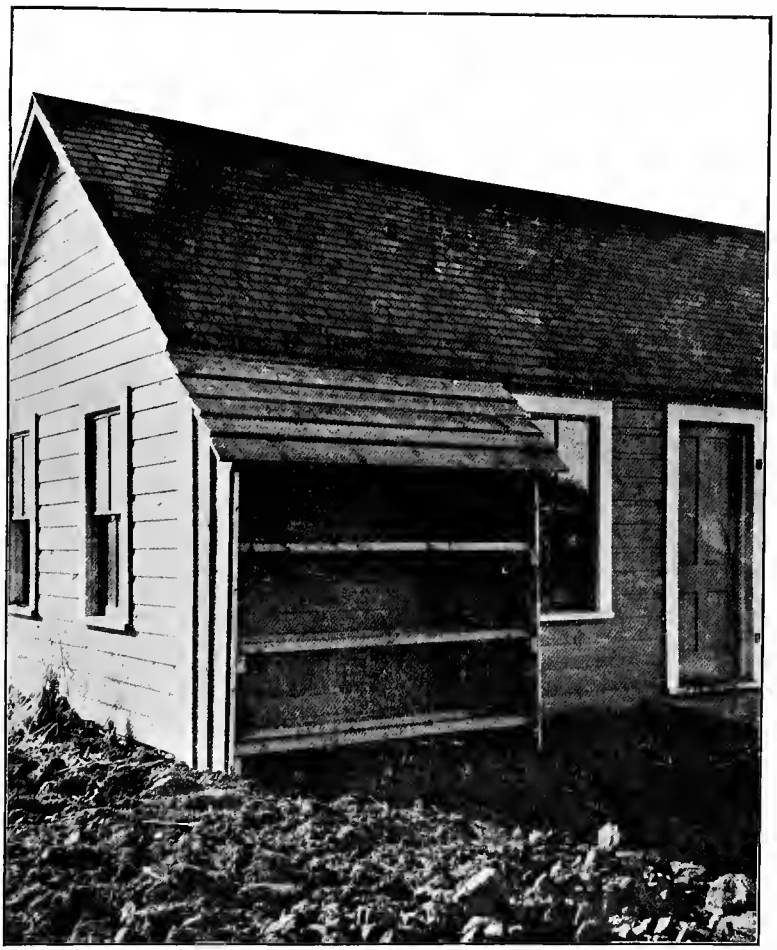
and is handy to carry combs to and from the extracting room.

Where one intends to keep ten or more hives of bees it is advantageous, unless a special preference is held for honey in the comb, to procure an extracting outfit and install it in the room designed for use as a honey room. The principal piece in the outfit is an extractor. This consists of a can twenty to thirty inches in diameter and the height of an ordinary table, fitted with a faucet at the convex bottom which causes the honey to drain out through the faucet. Mounted on a pivot in the center of the bottom and connected with a crank at the top is a comb basket holding from two to six Langstroth combs and capable of being revolved rapidly by means of a crank. The modern extractors are arranged with reversible comb baskets so that the honey can be thrown from both sides without removing the combs from the extractor. For the small apiary the Cowan reversible extractor, holding two combs, is a convenient and popular size. The extractor should be stood upon a box or low bench high enough to permit the honey to be drawn off below. As the honey will have particles of wax in it, a thin cheese cloth sack, should be provided to tie over the faucet and strain the honey through. This cloth should be wet before tying on, as otherwise the honey is slow to pass through. A cover of similar cloth or heavier to fasten down over the top of the extractor prevents dust from settling in the extractor when not in use.

There are several styles of honey or uncapping knives used to remove the cappings, prepatory to placing the combs in the extrac-

Figure 12.—The Quinby uncapping knife.

tor. They are designed along general principals. The first, of which, the Bingham knife is an example, is a narrow thin blade, capable of being bent, with the tip curved up and the handle elevated so that the blade can be brought parallel to the combs, the idea being to be able to reach all the little indentations of the comb. The second type is heavier, broad, and with a pointed tip at a greater or



Roughly constructed storm shed for winter protection of bees. See plate V. (Photograph by R. A. Cooley.)

Hives in place for winter ready for boards and straw to be placed across the front. (Photograph by R. A. Cooley.)

less angle. Here the idea is to make the comb conform to the knife by shaving all down to the lowest level. An example of this style is the Quinby knife. They both have their advantages, but for rapid work, the Quinby seems to serve better, although there is in its use the disadvantage of having a good deal of honey in the cappings. To hold these cappings and permit them to drain, some sort of an uncapping can must be provided. Where only a few hives are kept a milk strainer over a tin pail answers the purpose. Where more bees are kept, what is known as a Dadant uncapping can is a good investment. This consists of two parts. The lower portion is simply a can with a faucet in it to drain the honey off. The upper portion is another can but with a heavy wire cloth bottom to allow the honey to drain into the can below. To support the weight of the cappings a post is set in the center of the lower can. Across the top of the upper can is placed a wooden frame in which there is a pivot where the comb can be rested and turned as the cappings are being removed. This also provides a place where the cappings can be scraped from the knife without danger of dulling the latter. After the cappings have drained long enough or until they cease to drip which would be several days or longer, they may be dumped into a pail or tub and washed, scrubbing the wax with the hands. Warm water, not hot enough to melt the wax, will dissolve off the thick honey better. Then the water can be drained off and utilized

Fig. 13.—The Bingham uncapping knife.

in the production of vinegar. As a simple test to see if it is of the right constituency, an egg may be floated in it, honey or water being added until the egg just floats. The proportion of honey for vinegar should be one pound of honey to a gallon of soft water, preferably rain water. A vinegar barrel may be used filling it not more than two-thirds full and giving plenty access of air by placing it on its side in the sun and opening the side and end bungs, covering the openings with fine wire gauze to prevent the entrance of gnats. To hurry along the process of fermentation some mother of vinegar may be added or a gallon of previously made honey vinegar or

good cider vinegar if the other is not to be had. Honey vinegar is rather slow in working but of excellent quality, being a clear, almost white color and sells well in the warket.

The cappings, after they are again drained, together with any other accumulations of bits of comb, may be rendered into wax. One of the most inexpensive devices for the rendering of comb into wax is the Doolittle solar wax extractor. This consists of a wooden box usually longer than broad, arranged with legs near one end so that it can be raised up at an angle toward the sun. The interior is fitted up with a concave tin lining to hold the bits of comb separated by a wire cloth straining screen from the wax pan at the lower end of the box. The box is fitted with a double glass cover which concentrates the heat of the sun. Over this, when not in use, comes a wooden top covered with tin to protect the glass and keep out rain. It is best to remove the cake of wax after the first cooling, even though it be a small one, as each additional heating darkens the wax. Where there is a sufficient quantity of comb to be render-

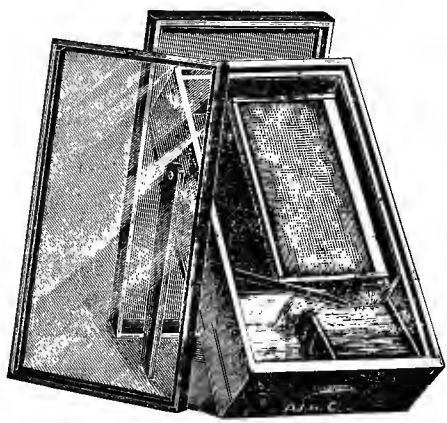


Fig. 14.—Solar wax extractor.

ed it is well to sort it out putting all the light pieces separate so that the light wax from these pieces may be kept separate. The cocoons and other impurities left in the extractor when melting up old combs may be removed to a box with a paddle and form excellent material for starting fires.

There are several types of steam extractors. The essential

features of these are a boiler for water, above which is placed a can containing a basket made of perforated zinc or heavy galvanized wire cloth to hold the comb. In the better forms within this basket is arranged a press so that the rendering of the combs into wax is greatly facilitated by pressure. Rendering comb by steam is a much quicker process and where a large amount of wax is to be thus prepared it pays.

While the average person keeping bees will usually buy his comb foundation already made, yet he may be interested in knowing something of the process. The thin sheets of wax are prepared by dipping. For this purpose a good sized tank is prepared with heated wax in it. Dipping boards of about three-eights inch stuff

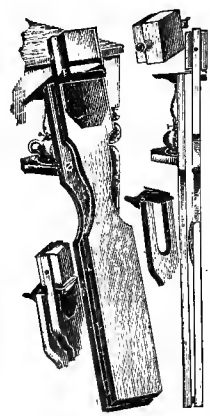


Fig 15—The Daisy foundation fastener.

with the edges pointed and of the width of the sheets desired are first dipped into cold water nearby, then dipped into the melted wax. Tto prevent too much water adhering to the board it may be wiped by a sponge when once well soaked. After cooling a moment the sheets of wax may be stripped off, running the thumb nail along the sharpened edges to start the sheet. These sheets are then allowed to stand in a cellar for some days. Then after dipping in tepid water the sheets are run through the foundation mill. This mill consists of double rollers bearing the impression of the bottoms of the cells and operated by a crank much like a washing wringer. To prevent the wax from adhering to the rollers they are lubricated by soap suds or starch. Flour paste is a simple and hand-

ily applied lubricant. The sheets may have a tendency to stick to one of the rollers. To prevent rolling back, the edge must be started and to prevent tearing, a clamp should be used pulling on the sheet across its whole width. The sheets may then be trimmed and before storing away should preferably have thin tissue paper placed between them to prevent sticking.

It will be seen that where any number of colonies are kept, to house the various implements and to store empty hives and surplus combs, some sort of a shop is desirable, and preferably a honey room also. In storing away combs it is essential that they be placed where mice cannot get at them, as mice are very fond of honey. Also proximity to ants is a nuisance. The greatest enemy to combs are the larvae of the wax moth. There are two species of moths which lay their eggs about bee hives and combs. They are of a dull gray color one a little larger than the other, and should be destroyed when found about the hives. The larvae feed upon the wax and spin their cocoons out of wood fibre on the edge of frames or in the crevices of the hives. Fortunately this pest is rarely if ever found in this state, and precaution should be taken not to introduce it with shipments of bees. Should combs become infested or be liable of infection, they may be fumigated with bi-sulphide of carbon. This may be done by tiering up the stories filled with combs and then placing the chemical in a can in an empty story at the top, when the fumes will settle down and destroy all the larvae if there be any. After this the combs may be stored safely away until spring when they should be put under the protection of the bees as soon as possible. No fire should be used about bi-sulphide of carbon as it is very inflammable and mildly explosive.

MODES OF WINTERING

Since much that is to follow in regard to the spring and summer manipulation and management of bees, is based upon the assumption of successful passage of the winter, we will hasten to discuss this—one of the most important problems in our state, and one which has received careful attention for several winters past in the experimental work of the Station. The results presented in these succeeding pages were obtained from or verified by experiments conducted during the winters of 1901-02, 02-03, 03-04, and

04-05. To facilitate these experiments and the general work of the apiary a clapboard, one story building was erected on the Station farm just east of the poultry buildings. This bee house contains three rooms, one for a shop fitted up with a work bench and the necessary tools, a second for a honey room, containing the extractor, uncapping can, honey tank and tubs, together with scales and table and all the necessary things for canning and labeling the honey.

At the back side of the building, and running the length of it, is a room with a dirt floor fitted up with two skeleton shelves of two-by-fours so that some forty or fifty colonies of bees may be wintered under as nearly normal conditions as possible with the entrances connected with the outside, permitting the bees to fly at will. Above these rooms in the gable roof, is ample storage room for empty hives and for surplus combs when not in use for the honey harvest.

During the first two winters prior to the erection of this bee house, experiments were carried on in outdoor wintering and in packing a number of colonies in straw under one roof. The experiments during the last two years were not only modified by the indoor wintering with packing only above the colonies but also by packing colonies in straw in an open shed against the side of the house. (See the accompanying figures.)

Tests were also made of the wintering qualities of Carniolans, Italians, Cyprians, Cyprio-Carniolans and Caucasio-Carniolans. The queens of these races and crosses were obtained through the courtesy of the agricultural workers of the bureau of Entomology, at Washington. The various qualities of these varieties of bees have been discussed in full in earlier ages. The Carniolans seem to hold the lead as winterers, though the marvelous powers of the Cyprians and their crosses to build up in the spring quite in contrast to the Italians, make them worthy of notice in this connection, as good winterers for this if for no other reasons.

The methods of handling bees in Montana, as in some other localities, in the late summer and fall, has a good deal to do with their successful wintering. This is particularly true in the Gallatin Valley, where there is no autumn yield of honey. By no yield we do not mean that absolutely no honey is gathered but that there is no harvest beyond what is needed by the bees. We observed that

after about the tenth to the fifteenth of August there is no chance of securing surplus honey. If the top stories be left on the bees may store in them, but this is very detrimental as then the honey is scattered and not compactly stored as it should be in the brood chamber. So that after the last extraction, about the tenth of August, the combs should be returned only for a day or two until the bees have cleaned them up, when the stories should be removed and packed away for the winter. In the case of supers the same rule applies. In fact, there is no use in putting on empty supers after the last of July, except perhaps in an unusually good year.

The bees will then continue to work for about two months, gathering enough in that time to keep the queen laying and so keep up the strength of the colony and leave them strong enough for the winter. Most colonies unless exceptionally weak will store enough honey for their winter supply. If there are any weak colonies when finally examined before winter, they should at this time be strengthened up with brood from the exceptionally strong colonies or else united with other weak colonies. In this climate where the winters are long and severe it is particularly desirable that weak colonies be doubled up since if left separate they are almost sure to perish before spring. The two or three colonies to be united, if near each other, should be brought gradually side by side moving them a little each day. All but one should be made queenless, selecting to be preserved the best queen, or, if there is no difference, retaining the one in the largest of the colonies to be united. Then after these preliminaries, when the colonies have had time to realize their queenless condition, which will perhaps be a day or so, just at dusk the combs of bees may be set over into the hive selected to hold the new colony. Before doing this the queen with a few bees should be confined in a wire-cloth cage, commonly used for introducing queens and described in detail in the section on queen rearing. After the bees are all in together it is well to smoke them thoroughly. Some beekeeers practice sprinkling a little sugar syrup over the bees, just enough to feed them well, but not enough to daub them seriously. It is often well to feed them a little, and in all cases it should be seen that enough honey is in the colony to keep them through the winter.

There are various forms of feeders mainly of two types,—one where the bees come directly in contact with the vessel of syrup

or honey, and the other where the bees suck the food indirectly. There are, further, two ways of feeding bees,—at the entrance and from above. Where one has but a hive or two to feed, it is not necessary to invest in any elaborate apparatus. A salmon can with a bit of comb or a chip in the syrup to serve as a float may be placed in an empty story or super above the brood chamber, turning one corner of the quilt back so that the bees may reach the syrup. Feeding should always be done at night so that there will be no chance of robbing among the bees. If the nights are chilly a piece of sacking or quilting may be placed over the feeder in order to retain the heat of the colony, first placing a block across the can to prevent the covering from closing the can. The syrup should be slightly warmed when fed to the bees, as they will carry it down more readily. It is prepared by melting one pound of cane sugar to a quart of water. A little vinegar may be added to prevent granulation. It is found that on the whole bees winter better if their stores are not granulated.

If the colony needs considerable feeding, it is better to feed it in larger quantities, since feeding in small quantities stimulates by a sense of continuing supply of food, to the rearing of brood which is undesirable in the late fall. Early in the fall it is well to feed slowly as it is highly desirable to have plenty of young vigorous bees for the winter. This is the plan of feeding adopoted during the spring months where feeding for stimulation is followed. In this climate each colony should have not less than thirty to forty pounds of honey or syrup. Bees may winter on less but the honey-filled combs are an added protection to the clusters, as the heat is thereby retained more readily. Thus it is advisable to feed by the quart or even two quarts at a time.

A convenient feeder can be made by removing the porcelain from the top of a mason jar and punching the latter full of holes with an awl or a wire nail. Then, screwing the cap thus perforated tightly upon the jar of tepid syrup and inverting the latter quickly upon a stand or simply a couple of blocks above the frames, the bees can take the syrup without coming in contact with the large volume of syrup and thereby running the risk of being drowned. The bees will take the syrup from the holes as fast as it flows if the holes are not too large and they will manage it even if it drips, if the jar be placed near enough level to prevent its

running too fast. These same feeders may be used at the entrance by having an enclosed passage about the opening of the jar leading into the entrance. The plan of feeding at the entrance is not so good if the nights are cold.

It is needless to say, that in preparing bees for the winter one should be sure to have in each colony a good prolific queen, preferably of the current year's raising. This is necessary to insure that brood rearing will begin at the proper time in the spring thereby replacing the old bees which die off rapidly at that season.

With these matters attended to, the next essential is to have a warm, dry and quiet place in which the bees may pass the winter. It has been our experience that with a colony that is strong enough to generate sufficient heat the matter of guarding against dampness becomes the all important matter. If bees are disturbed during the winter months they move about generating an undue amount of heat and at the same time a considerable amount of water vapor which condenses, coming in contact with walls of the hive, producing dampness. More than this, the bees consume more food when moving about and from this excessive feeding, diarrhoea may result, for normally the bee retains the feces in its body until such weather comes as will permit it to fly out of the hive and cast it out. In the case of diarrhetic bees the best remedy is a cleansing flight and if the weather will permit, bees wintered in cellars should be carried out for a few hours flight in the midddle of the day, in case of infection with this malady.

Outdoor wintering is usually accomplished in chaff hives and one great objection is the expensiveness of these hives. Otherwise since it is the most normal condition for bees, this method is to be recommended for inexperienced beekeepers. The feature of these chaff hives is a double wall with from three to eight inches of space between the walls on all sides including the bottom, filled with some non-conductor of heat like straw, chaff, paper or ground cork. The effect of this packing is to retain the heat and at the same time permit the moisture produced by the bees to pass off. To further permit this moisture to escape the oil or carriage cloth quilt used in summer is removed and a canvas quilt placed over the frames. Above this, newspapers, a piece of old quilting, or a chaff tray may be used to retain the heat. Then, above this material to retain the heat there should be an open space with free ventilation

accomplished by auger holes through the gable ends of the roof. The roof and whole hive should be thoroughly painted, and the hive placed several inches off the ground to prevent freezing and thawing and the attendant soaking up of water. The entrance formed by a bridge passage-way through the packing at the usual place is contracted to an inch or so for the winter. There should be in most instances no trouble in wintering bees so packed if they are strong in numbers and with plenty of stores.

Similar conditions may be approached with single walled hives by placing winter cases around them and packing chaff or similar material between the two walls thus formed. The disadvantage of this is that the thick wall of the inner case next to the bees and separating the packing material from the colony furnishes a cold surface for condensation.

In the chaff hives the inner case is made of very thin boards spread somewhat where joined and in some instances bound straw or even a heavy quality of canvass forms the inner walls. The idea is to bring the packing in the closest proximity to the cluster. Several single walled hives packed close together in one long case with straw about them were wintered very successfully several times at the Experimental Station. In our tests the percentage of loss among colonies wintered outside in chaff hives was found not to exceed those lost wintered in straw or those placed in the bee house. The colonies placed in the small winter room of the bee house were connected with the outside for flight, thus establishing normal conditions. The only packing they had was a tray of chaff above the canvas and a felt paper quilt above the canvass quilt. In the coldest winter weather the temperature of this room was found to be quite moderate, due to the heat generated by so many colonies of bees enclosed in so small a space.

One method widely practiced in the northern states and Canada is to winter bees in dry cellars. Late in the fall before cold weather comes on, after the bees have been put in shape inside and cloth quilts with perhaps felt paper quilts, newspapers or chaff trays placed above, the colonies are carried to a dark cellar. Here the entrances, temporarily closed while moving, may be opened and plenty of ventilation given above, the covers even being removed. The temperature of the cellar should be kept evenly at about 42 degrees Fahrenheit. This should never be permitted to vary more

than two or three degrees at most, and the bees should not be disturbed after once in place until spring weather has opened up. Great care must be taken not to take the bees out too soon as they would naturally be easily chilled after being in the even temperature of the cellar, should a sudden cold snap come.

Right here it may be noted that the killing of bees during winter by cold, is usually accomplished by the chilling of small outside clusters by successive cold snaps until the colony is so dessimated in numbers that it cannot withstand an unusually cold wave. Starvation sometimes occurs when the cluster of bees is caught by a sudden cold snap away from its stores and, of course, not being able to move, will starve, even though plenty of stores are in the adjoining combs. To prevent this, some beekeepers cut small passage ways through the combs with a pocket knife or place a stick across the top of the frames, over the cluster, to raise the quilt up and allow the bees to pass over the frame to the adjoining combs. These percautions are obviously not so necessary when wintering in the cellar.

To regulate the temperature of the cellar water is sometimes placed there in large vessels as it is a great evener of temperature. Care must be taken not to cause dampness if this plan is followed. A plan to secure ventilation without changing the temperature described by Professor A. J. Cook, now of Pomona College, but for some years an experimenter along apicultural lines when in Michigan, seems feasible. Air is conducted into the cellar by pipes from a distance of one hundred or two hundred feet, so that it will become tempered either with cooler or warmer air by the time it reaches the cellar. To establish the current of air a pipe, running up through the floor above, is connected with the stove pipe of the kithcen stove, above the damper so as not to destroy the draft. Every time a fire is started a current of air is drawn up and so an incoming current along the underground pipe is established.

In the spring one of the first things to be done about the apiary is to take a look at the stores of each colony and at the same time remove from the bottom board the accumulation of dead bees and knawings. Care must be taken not to start robbing, as the bees are inclined to rob at this season as also late in the fall. Not much smoke should be used or much manipulating done very early in the spring, as often the bees are incited to attack and ball the queen,

killing her in the excitement. If there are any light colonies, they may be given combs from the heavier ones or fed. Many beekeepers favor the plan of spring feeding whether the bees actually need the food for stores or not, for the sole purpose of stimulating them to rear brood. Feeding done for this reason is only done once or twice a week during the spring, until the bees begin to gather honey from the early flowers and only a little is given them each time.

It is important at this time of the year that the bees have plenty of pollen. If there are any pollen combs stored among the surplus combs by accident they may be given for brood rearing purposes. For this reason the taking away from bees of pollen combs in the fall, advocated by some beekeepers, is discouraged. It is an unnatural procedure and the bees themselves, if they have plenty of honey, will not use the pollen any more than just enough to repair the nitrogenous wastes of the body. It is absolutely necessary that the bees should have plenty of pollen in the early months of the spring when active brood rearing is carried on. We have observed bees gathering pollen here in the Gallatin Valley the last of February, when brood rearing operations had begun.

Manipulation to increase the brood production, as described in the section on the tehnique of handling bees, may be followed as soon as the spring really opens up and there is no danger of chilling the cluster or brood by enlarging the brood area with empty combs. Much of the skill of the beekeeper is brought into play at this time of the year, when the bees are to be brought through this, perhaps the most critical season of the year. Building bees up is almost a science itself, and will receive more attention under the Production of Honey.

QUEEN REARING

This is in itself one of the important branches of Apiculture. There are those who make this their chief work and, instead of shipping honey to the market by the ton, as some of the larger beekeepers do, send out queens which number hundreds and even thousands. Even the honey producer finds it desirable to rear young queens, sometimes in large numbers, to replace old and failing queens in his honey colonies.

The normal condition of the colony for the production of queen

cells is of course prior to swarming in the spring. But, if the proper conditions be brought about, there is no reason why good queens cannot be produced earlier or later than this particular time of the year. It is often advantageous in the economy of the up-to-date apiary to rear young queens in large numbers prior to the swarming time, for use in the artificial swarming or in the control of swarming spoken of at length in the following section, and for this reason we consider the matter of rearing queens at this point in our discussion.

The first preparatory step to inaugurate the raising of queens is the dequeening of a good strong colony which has an abundant supply of emerging bees. In twenty-four to forty-eight hours the bees will have fully realized their queenless condition and be well in the notion of starting cells. There are several ways of procedure to prepare cells. One mode is to take a frame of young larvae less than three days of age, since up to that time, it will be recalled, the larvae have been fed upon only the rich secretion of the nurse bees, and strip off narrow pieces each of a single row of cells in width. The cells on one side may be shaved down nearly to the base, and then the strip with the cells of the opposite side intact secured with hot wax to the top bar of an empty frame. One or two additional bars may be placed in the frame and strips fastened to them in a similar manner. Then with a blunt sliver or match stick, two out of every three larvae may be destroyed. This will give room for the bees to build down the queen cells without joining them to each other. Two or three frames so prepared or even four may be given to the queenless colony. At the time they are inserted, all unsealed brood should be removed and frames of emerging bees inserted, if available. It will be seen that all the nurse bees will then be able to give their whole attention to feeding and caring for the prospective queens and that the numbers of emerging bees will reenforce and swell the numbers and efficiency of the nurses, the result being that a large amount of royal jelly will be allotted to the queen larvae. To increase this secretion and also the secretion of wax with which to build down the cells and to ease the queenless condition of the colony generally, the bees may be stimulated by liberal feeding each day. In this way large well shaped cells with well fed larvae will be obtained.

Another method employed by some is to use a series of queen

cell cups collected from combs, fastening them to the bars of the frame prepared for the purpose as above. Then, to each cup a bit of jelly, secured from the unsealed cells started by the colony after being made queenless and prior to the removing of the unsealed brood, is allotted. Then, by means of a sliver or toothpick bent at the end, or by the use of a little metal ladel, especially prepared for the purpose the young larvae are transferred from the comb containing the brood from which it is desired to rear the young queens, to these cups. Some beekeepers prefer to go a step further and use artificially made cells prepared by dipping, and encased in wood or other materials such as fine wire gauze, each being provided with a point like that of a tack, for attachment to the bars. The transferring process is the same in the use of these. The advantage in the use of such cups is the ease with which they may be removed and distributed when they reach the proper stage of development.

There are beekeepers who prefer to rear queens under what they believe to be more nearly normal conditions, that is, those conditions which prevail when the cells are produced prior to swarming. This school of beekeepers believe that cells reared in a queenless colony are liable to be hurried along by the bees anxious for a queen, and so do not receive the proper care and attention. So they place the frames prepared in one or the other of the ways above indicated, into the top story of a good strong colony, having previously seen that the queen is in the lower story and having inserted between the two stories a zinc honey board or queen excluder. The latter is a sheet of zinc the size of the top of the hive perforated with passages just large enough to let the worker bees through, but not of a size to permit of the passage of the queen. This excluder is such as to keep the queen from the top story when extracted honey is being produced. The colony then goes along in its normal condition and a fine quality of queen cells is produced above.

Another method used by some, on the same principle, is to partition off the central portion of the brood chamber with queen excluder zinc and placing the previously prepared frame of cells in this central apartment, allow the queen to follow her usual duties of egg laying on both sides changing her from one side to the other, to furnish her empty cells in which to deposit eggs. In this way the

warmth and attention of the center of the brood nest is given the queen cells while the queen is kept from destroying them as she would be liable to do unless under the swarming impulse.

It will be noticed that, in the last two plans, which in principle are the same, the brood rearing of the colony goes on as under normal conditions. In the first plan outlined there is no brood rearing save that of the young queens, and furthermore, all the unsealed larvae are removed for the express purpose of relieving the nurse bees of the care of so much brood, so that they may be able to give all their time and strength to the queen cells being formed. In addition, care is taken to provide an extra force of nurses by giving the colony emerging frames of brood. These conditions seem to be most favorable for the production of well developed queens.

We pass now to the second operation of queen rearing, that of providing for the care of the young queens and their mating. It would obviously be a great waste to dequeen and use full colonies for this purpose. So what are called nuclei are formed to receive the cells when they are about ready to emerge. The nucleus box of the most convenient size has been found to be one taking about five frames, each one-third the size of a Langstroth frame. This approximate size has been chosen because of the ease with which a queen can be found and still enough combs are had so that the young queen can organize her brood as in a normal colony. The exact size of 9 1-3 inches by 5 7-8 inches has been chosen so that just three of the frames will fit together to form a Langstroth frame, which has been found to be quite an advantage in uniting nuclei with colonies or several nuceli together in the fall for wintering and then, too, the frames can be inserted in a full colony in the spring to be stocked with brood bees. With combs thus stocked the making of nuclei becomes a very simple matter, as they have simply to be set up bees and all. But in the case of nuclei formed by brushing bees from the combs of a full colony, the bees usually have to be confined for a day or two and the boxes set in a dark place, until they become accustomed to the smaller hives, when they may be rowed out in the apiary on benches or blocks of wood, ready for the insertion of ripe queen cells. In this way eight or ten nuclei may be formed by breaking up a single colony or, if preferred, the nuclei may be drawn singly from a number of different colonies without any preceptible decrease in the strength of the latter. The number of nuclei de-

sirable to have will depend on the number of queens to be reared. Ordinarily each nucleus will turn out two to three queens each month if properly handled.

The cells, when within a couple of days of the time of emerging, which will be about five days after sealing, may be removed from the colony where reared and distributed one to each of the nuclei. The next day the nuclei should be examined to see if the cells are accepted. If any are destroyed they should be replaced. Then the cells should be watched and the day of emergence noted.

Usually four or five days and sometimes even a week will elapse after the emergence before the young queen takes her bridal flight. She may fly several times before fertilization is accomplished, but when accomplished it will be denoted by regular deposition of eggs. Sometimes a newly mated queen can be seen upon the comb having but just returned from her flight. A white spot is plainly visible upon the tip of the abdomen where the portion of the drones reproductive organ retained in the act of copulation is still seen. In opening nuclei containing virgin queens, care should be taken not to alarm them lest they take wing and perhaps, if they have not yet flown, may not get back into the right nucleus. For this reason it is well to have nuclei pretty well separated. Sometimes, on the return of a newly mated queen, the bees, taking a dislike to the odor, of the drone about her, may pitch upon and ball her, so disabling her that she is of little or no value. There occurences, however, are not very common.

A young queen thus regularly laying is ready for use about the apiary or for sending out by mail to other parties desiring queens. Such a queen when sold is classed as an untested queen, since her exact mating is not known. Upon keeping a queen three or four weeks, until her progeny have emerged, she is classed as a tested queen if her workers prove her to have been purely mated; that is, with a drone of the same race or variety. It is to be noticed in this connection that the daughter of a pure or imported queen, no matter what her mating is, will produce drones of the race of which she came, since they come from unfertilized eggs. Her workers and queens, bred from her, however, necessarily partake of the character of the drone with which she mated.

The disposition of the young queens when fertilized and ready for use, leads us into the discussion of the mailing of queens and

the introduction of queens into strange colonies. The preparation of a suitable cage for mailing queens long distances has made possible not only the introduction of many valuable races of bees, but also the whole industry of queen rearing and trade which in itself has grown to great importance. The most generally used cage now is the Benton cage, or a modified form of it. This cage was perfected by the writer's father, Mr. Frank Benton, when shipping queens from Munich on long journeys, even to Australia. At this time also was perfected the making of a suitable bee candy for food upon these long voyages and the discovery of the right ingredients. The pipe covered introducing cage of wire cloth which has been found to be one of the most successful devices for this work, was also constructed by the writer's father. A fuller description of it and its uses will be given later.

The Benton mailing cage is made of well seasoned, non-resinous, soft pine, in two or three sizes, the essential feature being not so much its size as its plan of construction, for the size may vary with the length of the journey. The domestic cage commonly also used as a trans-Atlantic cage, measures about three and a half inhces in length by an inch and an eight in width and three-quarters of an inch in depth. In this are bored three seven-eights inch auger holes, the first or end one of which is waxed to serve as a food apartment by pouring in melted wax and quickly pouring it out again. The third or opposite end apartment is supplied with six awl holes on each side for ventilation, these holes being sunk in a double groove on the outside so that no flat surface coming up against the cage in the mail sack can shut off ventilation. The middle apartment is designed as a place into which the bees can go if cold or to get away from the light of the end apartment. The passage way between these two apartments is made somewhat smaller than the entrance to the food apartment, to allow having the middle apartment secluded. The entrance to the food apartment must be large enough to insure against the possibility of one or two bees getting wedged into it and so cutting off the food supply of the rest.

The food used in these cages is a stiff candy dough prepared from pulverized sugar and well ripened light honey, kneaded to the right constituency. The waxed cell is filled with this candy and then sealed with a piece of combfoundation over the top, the cell previously having been rimmed out to receive this covering. The

cage thus equipped with a piece of wire cloth over the top and a thin board or paste-board cover is ready for the reception of a queen and her attendants, usually to the number of a dozen or fifteen according to the time of the year, distance to be sent and condition of the weather. The queen is usually put in first and may be removed from the comb by picking her up by the wings with the right hand. The cage, with the cover slipped back from the ventilated end, and held in place with rubber bands, is held in the left hand with the thumb in position to close the opening. Then workers are selected to accompany her and inserted successively. These should be neither too young nor too old, as young bees have not cleared their bodies of feces and old bees will not stand the journey. Some of them may have honey, one or two of them may be pretty well filled, but the others must be empty in order to care for the food in case of the latter's running and so prevent daubing. Also bees laden with honey do not travel well as they are easily shaken about the cage. The bees all in, the wire cloth may be tacked down and the cage leaned up against something, the screened side down to let the bees work out the particles of wood from the freshly cut cage. Then the covers may be nailed on. With a one cent stamp (domestic rate) the queens will be delivered to the purchaser.

The latter upon receipt of the queen will remove her and her attendants if in good condition to an introducing cage, the change being made before a closed window. If the bees are travel stained, very young bees may be placed in the introducing cage in preference to them. This pipe covered cage is made of a piece of wire-cloth rolled to form a cylinder about an inch and a half in diameter and secured at the seam by lacing. Incisions are then made in one end and the edges bent in to form the top leaving the cage about an inch and a half deep. Then about three-eights to a half inch is ravelled out at the open end, so that the cage may be pressed into the comb. There are other forms of cages as West spiral cage, made of spiral wire, and Miller's cage, a flattened wire-cloth box with the ends closed by blocks. The great advantage of the pipe covered cage is in its allowing the queen to be in a normal condition on the comb, with access to honey, all quite strong advantages especially after a queen has been on a long journey. Care should be taken in introducing with the pipe covered cage to have the adjoining comb close against the top so that the weight of the bees

will not pull it loose. A lazy way of introducing queens is to have a cork in the end of the food apartment and removing this merely insert the traveling cage in the colony and allow the bees to eat their way through, liberating the queen about the time they are ready to accept her.

It goes without saying that the colony should be made queenless before introducing a strange queen, preferably twenty-four hours before. The queen usually may be released toward night of the second or third day. All cells should be removed at this time and it is not a bad plan to feed the bees a little when about to release a queen.

These points, of course, apply in introducing queens at any time. It may be desirable to hold fertilized queens for a week or two and the pipe covered cage is adapted to this use as well. A dozen to twenty queens may thus be kept ready for use in a top story above a queen excluder preferably or in a queenless hive.

METHODS OF CONTROLLING INCREASE

We find firmly fixed in the bee that universal desire for the extention and preparation of its kind. It is shown in the persistent inclination of the bees to swarm at certain seasons of the year when the honey flow is on and the over-populus colony is beginning to feel its cramped condition in the hot spring and summer months The month of June is our swarming time and unless strict measures are taken to prevent its continuance, the month of July is added. In the Bitter Root Valley where spring opens up nearly two weeks earlier on account of being on the Pacific Slope, swarming may come earlier, in the last days of May.

The old way was to let the bees swarm and when found hanging on a tree, shake them into a box or empty hive, set them up and let them build their new home. Wire cloth boxes or swarm catchars with lids were devised for use in the tops of trees into which the bees were shaken and the cover closed and the whole let down with a rope when the bees were quietly clustering. The main thing in these operations was to secure the queen and then the bees would stay.

Plenty of ventilation must be given the newly hived swarm, especially if the weather is at all excessively warm. Care should be taken that the hive before putting the bees in, has not been standing in the sun and so become heated, and ventilation may be

given by proping the hive up from the bottom board or by putting a block under one corner of the cover. If the bees still persist in leaving, a frame of unsealed brood will always induce them to stay.

Should the parent colony be a strong one and the weather conditions favorable, the honey flow continuing, a week later when the young queens begin to emerge a second and even third and fourth swarm may be cast. In general, however, afterswarming is to be discouraged unless increase is the chief aim in view. This can usually be accomplished by running through the colony if accessible on the fourth or fifth day after the casting of the first swarm and destroying all of the queen cells except one or two of the best looking ones, watching those left and when one is out destroying all others. To be sure and get all the cells, the combs should be shaken as the cells not only occur along the edges but are also suspended in dry holes in the comb or are built out just below the bulge of the honey along the top. The plan of removing queen cells to prevent any swarming whatever has not been found effective. While it temporarily may defer swarming, ultimately it does not. It may in many instances prevent the actual casting of a swarm, yet all the conditions of swarming prevail. The bees cease work more or less, the queen diminishes egg laying and the brood combs become clogged with honey. The bees may finally swarm out leaving no cells or they may swarm on the strength of some stray cell overlooked. When bees once get in the notion of swarming it is hard to stop them.

Should it be desired to have no swarming in the apiary the first step should be to replace all of the queens wintered with queens of the current year's raising. Young queens are not near so likely to be persistent in swarming as old ones are. Then, either half stories or full stories fitted up with foundation starters may be placed between the brood rest and the bottom board. This gives the bees a sense of roominess and removes the necessity of swarming because of crowded quarters. The combs as fast as built down may be removed to top stories and empty frames with only starters put in place of them. The colonies should then be given plenty of room above for storing honey, and the honey removed as fast as ripened.

Should it be desirable to have each colony cast one swarm for increase, there is an effective way of handling natural swarms by clipping one wing of the queen. This should be done in the early

spring or in fact anytime after the mating of the queen is accomplished.

This may be done by picking the queen from the comb by her wings with the thumb and forefinger of the right hand. Then setting the comb down take the queen carefully by the thorax between the thumb and forefinger or first two fingers of the left hand and with a pair of fine scissors clip the upper right wing about half way up. Care must be exercised that in the operation a leg is not clipped or that the queen is not squeezed too tightly. Then, laying the scissors down the queen may again be taken by the wings and returned to the comb. She should be handled as little as possible, as the moisture from the hands tends to moisten and soil her.

When the colony swarms the queen may be caught in front of the hive and confined temporarily in an introducing cage on a bit of comb and placed in the shade somewhere where the bees will not find her. It is obvious that the grass should be kept short in front of the hives, that the hives should not be placed high off the ground and that a slanting board in front is very desirable so that, should the bees swarm when no one is about, the queen may get safely back into the hive.

While the bees are in the air the parent colony is removed from the stand and an empty hive with frames fitted up with foundation or with full combs, put in its place on the old stand. The bees after circling around in the air, missing their queen will return to the old stand. To hasten their return the cage containing the queen may be placed on the alighting board and, when they are well in the notion of going in she may be released and allowed to run in with the rest and the swarm is safely housed.

Among the cardinal points sought usually by beekeepers in the handling of swarms is to keep the strength or working force of the colony together for the production of honey. This is why some, not desiring to increase, prefer to have no swarms cast. In all swarming operations it is desirable to lose as little time as possible, not only in the working of the bees in honey gathering, but also in the production of brood. The desirability of having good strong colonies in the fall for wintering must not be lost sight of and also incidentally the securing of good straight worker combs should be remembered in manipulatin the colony at swarming time.

In view of these considerations when swarms are hived by the

clipping method it will be observed that the swarm being on the old stand secures all of the flight bees in the fields at the time swarming takes place and, having a laying queen, immediately starts brood rearing. To still more increase its strength the parent colony may be placed near it first with the entrance at an angle away from it and then gradually brought close beside it, with the entrance in the same direction by moving it a little each day. Then by picking up the colony and setting it on the other side with the entrance turned away, all of the flight bees will again be added to the swarm. This shifting may be repeated several times until the swarm is sufficiently strong. If increase is not desired this may be carried on until the entire parent colony is merged in with the swarm and the comb used for other colonies or as surplus combs, provided the queen cells are first removed. Should this not be desirable a young queen may be permitted to hatch out and the colony set up on a new stand as soon as the swarm has been sufficiently strengthened. Or better still, the cells may be removed and a young laying queen introduced as this will save nearly two week's time in the production of brood, quite an item at this time of the year.

There are several methods of artificial increase followed to evade the process of natural swarming. One way is to divide the colony equally, supplying a laying queen from a nucleus to the queenless portion, and in each case filling out the quota of combs. This divides the strength of the colony so that a better way is to simply draw off a nucleus by setting over into the empty hive a couple of combs with the queen and then supplying the old colony with a young laying queen. The parent colony is then left in a condition to store honey. The nucleus drawn off may then be given combs or full sheets of foundation and so gradually built up to the strength of a full colony. We say give them full sheets because the nucleus has presumably an old queen, that is not one of the current year's raising, and the tendency of the bees is to build drone comb unless they are very much crowded for space, which of course would not be the case with the nucleus.

Another plan is to form what is known as shaken swarms. These are formed by shaking the adult bees from the combs of a colony into a hive of foundation starters or full sheets of wired foundation. Prior to shaking, the bees should be well smoked and

allowed to fill themselves with honey so that the normal condition of bees when swarming will be established, for just before swarming bees instinctively gorge themselves with honey, this accounting in a large measure for their docility at the swarming time. The swarm so shaken may be placed on the old stand to retain the flight bees and the parent colony set up on a new stand. The plan of continuing to add flight bees to the swarm may be followed in this instance as described in connection with having natural swarms on the old stands. If the shaken swarm is placed on starters a young queen should be given it to insure the building of worker combs, the old queen being retained in the parent colony. If young queens enough are available it is well to replace the old queen at this time, for if left in the parent colony, the instinct to swarm may lead the colony as soon as strengthened up enough to warrant it, to cast a swarm in spite of having been greatly depleted in numbers by the previously shaken swarm.

There has been some objection raised to thus shaking bees from the brood combs of a colony, it being claimed that the brood is chilled and that the unsealed brood is but poorly cared for in the depleted condition of the colony. The plan should not be carried out until just before the honey flow when the nights are warm and the brood not likely to suffer much danger of being chilled. The youngest brood may be given to other colonies. Or still better the days immediately preceding the shaking of the swarm may be used to introduce a young queen (first removing the old one), and so the youngest brood will have time to get past the stage of needing so much attention and care. Some beekeepers prefer to put a top story on the colony to be divided a short time before it is proposed to make the division. Then the young brood is all transferred to this story and set down on the bottom board at the time of the division, the bees from the lower story then being shaken into it and the latter story set up on a new stand, as the parent colony and given a laying queen from a nucleus.

But it will probably be found that for the small apiarist the clipping method of controlling swarming will be the most natural and satisfactory.

PRODUCTION OF HONEY

Last, but none the less important are the operations of the apiarist attendant upon the production of honey. Indeed nearly all of the foregoing operations are brought to a focus upon this, the principal aim of keeping bees for profit. The successful producer of honey, as has been pointed out, must begin in the fall or late summer of the preceding year rather than just before the honey flow, as is too often done. The importance of this point will be readily seen when it is realized that to have a colony well supplied with bees at the time of the honey flow, that is, bees old enough for work in the fields, the colony must be stocked with eggs about five weeks or longer previous to the flow. But colonies will not be in this prime condition so early in the spring unless wintered well with a good supply of strong bees bred in late summer the previous year. To accelerate the production of brood, stimulation by spring feeding, as previously outlined, is an excellent course to pursue. Then manipulation to enlarge the brood nest may follow and, if pollen is not plentiful in a colony, frames of pollen added. Should there be a dearth of pollen, which is not likely to be the case, artificial pollen food may be supplied in the shape of graham flour. This may be dampened and placed in pans near the bees where they will find it. In these ways early brood rearing will be established and the strength of the colony rapidly increased in the weeks preceding the honey flow. Then if the swarming problem is handled properly, so that the strength of the colony be kept together, a good yield of honey will be assured. The manipulation here will depend somewhat upon whether one is running for comb or for extracted honey. Shaken swarms on starters below, or first swarms hived on the old stand with the flight bees added, also on starters, make good colonies for producing nice white clear comb honey. For the production of comb honey the colony must be very strong. If only a limited increase is desired this may be secured by shaking together the bees from two adjoining colonies, first removing the queens and returning the latter to the parent colonies respecitvely after the operation. The new colony so made should be on starters and may then be given a young queen newly fertilized from a nucleus. The bees being excessively strong in numbers and bearing on starters below will immediately go to work in the super placed above, with section containing full sheets of founda-

tion or previously drawn out comb obtained perhaps from the season before. Having a young queen of the current year's raising, the building of worker comb in below when only starters have been used, is assured. If an old queen be retained full sheets in wired frames should be used. If the nights are at all chilly it is well to have a quilt above the supers held tightly down, with papers between it and the cover, for the double purpose of retaining the heat of the bees for building operations and to prevent the bees from soiling the tops of the sections by daubing propolis over them. Nice clean sections add much to the salable quality of comb honey.

In supering the old colonies it is well to do so before there is much honey stored in below. As soon as the bees begin to whiten the combs of the brood chamber the supers may be put on. If one has a honey extractor available the brood frames may be carefully extracted, care being taken to turn them slowly in the extractor and longer than when no brood is in the combs. The queen will then get the frames below filled with brood if they are extracted at the right time when the outer cells are emerging and eggs are being deposited in the inner cells. The bees will then be forced into the super to store their honey. If the brood chamber gets clogged with honey it not only discourages the bees from crawling over the sealed honey to store above but crowds the queen and is likely to cause the colony to cease work and encourages swarming. When the bees begin to seal the honey in the super a second super may be put in place on the hive, elevating the first and putting the second below it. When the first is ready to be removed, the bee escape board previously described should be inserted taking care not to smoke or excite the bees lest they bite into the capped honey.

Comb honey should never be stored in a cold or damp place. Honey is deliquescent and if subjected to a damp atmosphere will gather moisture and bursting the cappings the honey will begin to run and then sour and ferment. Under the proper conditions comb honey, however, may be kept indefinitely.

Probably more honey in proportion to the number of colonies may be obtained when the apiary is run for extracted honey. This is due to two reasons, namely, first, there are many colonies which would not store honey in a super because of their insufficient strength, and, second, the combs for extracting are already built or at any rate are built but once in the season after which they are

used over and over again, the bees thus being permitted to spend all of their time and energy storing honey which is quite an item especially if the honey flow is a short one as is the case in Montana. The building up of colonies as outlined above applies equally for extracted honey, yet usually honey colonies or those colonies especially prepared for the harvest, are not permitted to swarm and are not driven or shaken. Provided with young and prolific queens these colonies are bred up to overflowing with brood and bees. To prevent swarming half depth stories or even full stories usually only with starters, but sometimes with full sheets of foundation on wire, if the combs are needed, are kept below the brood chambers. As fast as the frames of these stories are filled with comb they are removed and empty ones put in their places, fitted with foundation of course. Above the brood chambers is placed a zinc honey board or queen excluder. This is simply a sheet of sinc perforated with oblong holes large enough to permit of the free passage of the w rker bees but not of the queen or the drones. These zinc sheets are usually bound with wood giving a bee space on one side and should be placed with this space up as there is normally a bee space above the combs. There are also slatted wood queen excluders which are made of alternate strips of wood and perforated zinc, thus doing away with the tendency of the full sheets of zinc to sag in the middle. This sagging in the case of the full sheets may be remedied by placing strips across the top bars of the lower story. The lower stories having been extracted and gotten filled with brood the top stories may then be put on and when partially filled a third story may be inserted between the lower and top stories. In the case of very strong colonies it may be advantageous and profitable to put on a fourth story. It is better to do so than to take the honey off before it is well ripened. Unripened honey may not only lose its aroma and flavor but may even sour.

Extracted honey should always be allowed to stand in an open vessel for a day or two thus allowing the scum to rise which should be removed. It may then be drawn off into sixty pound tins or even barrels for shipping or storing purposes. Or if to be immediately marketed smaller cans or jars or bottles may be filled and labelled. Honey should be graded. To facilitate this it is well to sort the honey when extracting it or to watch the flow from a given

source and then extracting that honey before the bees begin a new source.

The granulation of honey after being gathered especially in cold weather is looked upon as a sign of its purity. It may be again easily rendered liquid by heating, the containing vessel in a can or boiler of hot water. Very high temperatures should never be applied to honey as it has a tendency to destroy the flavor and aroma.

The foregoing at best is but a brief outline of the subject of bee-keeping and for one interested in the keeping of bees there is nothing better than to become a close reader of one or more of our bee journals. In this way many different methods of operating an apiary may be learned and the whole subject slowly mastered. A list of the bee journals published in this country is here given.

Gleanings in Bee Culture, Medina, O. (Bi-monthly.)
The American Bee Journal, Chicago, Ill. (Weekly.)
The Beekeepers' Review, Flint, Mich. (Monthly.)
The American Bee Keeper, Jamestown, N. Y. (Monthly).
The Progressive Bee Keeper, Higginsville, Mo. (Monthly.)
The Rural Bee Keeper, River Falls, Wis. Monthly.)

BEE DISEASES

It seems almost superfluous to speak of this subject as Montana bee keepers are so little troubled if at all, by the maladies which attack bees. The most common disease is that of dysentery and the best remedy a good cleansing flight. It only attacks bees in the winter and is caused by excessive dampness or soured honey due again to dampness.

There is a paralysis prevalent among bees which is found to attack only the adult bees and hence easily suppressed. It is a bacterial disease and the victims driven forth by the other bees may be seen black and shiny in appearance struggling with their uncertain movements away from the inflicted colony. Removing first all of the brood and honey of the colony, powdered sulphur may be strewn about the hive. Another way is to carry the infected colony or colonies away some distance, a half mile to a mile, and then to remove the brood as fast as it is bred and to save the progeny of the colony. The old bees will soon die off and the colony thus deplet-

ed will soon dwindle to nothing and so exterminate the pest.

Another bacterial disease of a more serious nature commonly called four brood is the bacillus of the hive. Its common name arises from the symptoms which are readily noticeable in the brood. The latter becomes dark and in the case of sealed brood if the sunken caps are removed the larvae or pupae in a dead condition are putrid, have a strong odor and are of a stringy or ropy consistency. The simplest remedy for the disease which is very contagious, is to shake the bees from the diseased colony into a box just at nightfall, when they are all in. The combs and honey may then be destroyed by burning and the hive disinfected by washing with corrosive sublimate made by adding one eighth of an ounce to each gallon of water. This same disinfectant may be used on tools and also on the hands after handling the diseased colony. The bees confined for two day in a dark place may be now fed a half pint to a pint of medicated syrup each day for two or three days. This syrup is prepared by adding one part of carbolic acid to six hundred parts of sugar syrup. Honey may be used if available. At the end of the fourth or fifth day the bees may be taken out and shaken into a hive provided with starters set up a little apart from the other bees.

Should there be considerable brood from several colonies it may be placed over one affected colony until the young bees have emerged and then the combs may be melted up for wax by boiling for several hours in hot water. The bits of comb built by the bees during confinement should be treated similarly. The wax on cooling should have the settlings containing any possible spores burned. Bees thus treated almost always can be cured. As far as we know there have been no cases of this malady in the state, and, in fact, it is not a very common disease, the writer never having met with an actual case in his experience.